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Agricultural Conference, 1905 (*Contd.*) :—

SUGAR INDUSTRY (*Contd.*) :—

CACAO INDUSTRY.

GENERAL.

LIST OF MANURIAL EXPERIMENTS.*

1. No manure plots.

2. Pen manure plots, each receiving 20 tons of pen manure per acre.

NITROGEN SERIES.

(a.) *With Potash and Phosphate.*

Each plot received a dressing of basic phosphate conveying 40 lb of phosphoric acid (P_2O_5), and sulphate of potash conveying 60 lb. of potash (K_2O), per acre. On these the following experiments were conducted :-

3. No nitrogen.
4. 40 lb. nitrogen as sulphate of ammonia in one application.
5. 40 lb. nitrogen as sulphate of ammonia in two applications—(i) 20 lb, (ii) 20 lb.
6. 60 lb. nitrogen as sulphate of ammonia in one application.
7. 60 lb. nitrogen as sulphate of ammonia in two applications—(i) 20 lb, (ii) 40 lb.
8. 40 lb. nitrogen as nitrate of soda in one application.
9. 40 lb. nitrogen as nitrate of soda in two applications—(i) 20 lb., (ii) 20 lb.
10. 60 lb. nitrogen as nitrate of soda in one application.
11. 60 lb. nitrogen as nitrate of soda in two applications—(i) 20 lb., (ii) 40 lb.
12. 60 lb. nitrogen as dried blood in one application.

(b.) *With Potash only.*

13. 60 lb. nitrogen as sulphate of ammonia in two applications—(i) 20 lb, (ii) 40 lb.

(c.) *Without Potash and Phosphate.*

14. 60 lb. nitrogen as sulphate of ammonia in one application.
15. 60 lb. nitrogen as sulphate of ammonia in two applications—(i) 20 lb., (ii) 40 lb.
16. 60 lb. nitrogen as nitrate of soda in one application.
17. 60 lb. nitrogen as nitrate of soda in two applications—(i) 20 lb., (ii) 40 lb.

PHOSPHATE SERIES.

Each plot, save one, received a dressing of sulphate of ammonia supplying nitrogen, and of sulphate of potash,

* To be inserted to face p. 371 of Volume V. [Ed. *W.I.B.*]

supplying 60 lb. of potash, per acre. The following experiments were conducted :—

18. No phosphate.
19. No phosphate: with potash and nitrogen, the latter in two applications—(i) 20 lb., (ii) 40 lb.
20. 40 lb. phosphoric acid as basic phosphate.
21. 60 lb. phosphoric acid as basic phosphate.
22. 80 lb. phosphoric acid as basic phosphate.
23. 40 lb. phosphoric acid as basic phosphate without nitrogen and potash.
24. 40 lb. phosphoric acid as superphosphate.
25. 60 lb. phosphoric acid as superphosphate.

Potash Series.

Each plot, save one, received a dressing of sulphate of ammonia conveying 60 lb. nitrogen, and of basic phosphate conveying 40 lb. of phosphoric acid, per acre. The following experiments were conducted :—

26. No potash.
27. 20 lb. potash as sulphate.
28. 40 lb. potash as sulphate.
29. 60 lb. potash as sulphate.
30. 60 lb. potash without nitrogen and phosphate.

Guano Series.

Ohlendorff's Dissolved Peruvian Guano.

31. 2 cwt. guano in one application.
32. 4 cwt. guano in one application.
33. 4 cwt. guano in two applications—(i) 2 cwt., (ii) 2 cwt.

Lime Series.

These plots received a dressing of sulphate of ammonia conveying 60 lb. nitrogen, and of basic slag conveying 40 lb. phosphoric acid, and of sulphate of potash conveying 60 lb. potash :—

34. No lime.
35. 150 lb. lime (oxide) in one application.
36. 300 lb. lime (oxide) in one application.

Errata in Volume VI.

Page 373, line 30, *after* 'twenty-five years,' *insert* 'and the acreage under cultivation in sugar-cane.'

Page 374, line 17, *for* 'curves' *read* 'causes.'

Page 374, line 26, *after* 'greater' *insert* 'than.'

Page 374, line 27, *for* '1905' *read* '1895.'

Page 375, line 21, *for* 'productions' *read* 'production.'

Page 376, line 17, *for* 'fund' *read* 'found.'

Page 377, line 19, *for* '£52,500' *read* '£45,358.'

WEST INDIAN BULLETIN

VOL. VI. No. 1.

AGRICULTURAL CONFERENCE, 1905.

(CONTINUED.)

CANE FARMING IN BRITISH GUIANA AND TRINIDAD.

BRITISH GUIANA.

The Hon. B. HOWELL JONES (British Guiana): The subject of cane farming received considerable attention a few years ago in British Guiana, and the labouring classes in villages near the sugar estates took it up at first with a certain amount of zeal, but difficulties came in the way. First, the extreme difficulty in transporting canes from one estate to another which were not joined together by aqueducts. Again, there was, and is, the difficulty of not being able to weigh the canes before they go into the mill: and at the first starting of the industry there was a certain amount of suspicion on the part of the labourer that he was not being fairly dealt with when his juice was being bought and paid for by the gallon according to polariscope test. On some estates, instead of paying for the juice by the gallon, the canes were bought by the punt load, as in British Guiana all canes are conveyed to our mills by punts. That also created a great deal of suspicion and managers of estates complained that the labourers did not load the punts up in the way they should. These difficulties have been in some measure overcome, chiefly because it is now clearly and fully understood by the villagers that the cane juice is bought by the gallon according to polariscope reading and paid for according to the market price of sugar of the day. A table was prepared by Mr. Scard (a gentleman whose name must be well known to nearly every member of this Conference, and whose very serious illness I am sure every one of you regret) for the Royal

Agricultural and Commercial Society as to the value of cane juice, and that has been adopted as a standard, by which cane juice should be bought and paid for, except in cases where canes are brought to the mill in very small quantities. The scale starts from a value of 2c. with a polariscope reading of 1·50 ℔. per gallon, and valuing a .gallon of cane juice at 1·50c.; sugar valued at 2·05c. per ℔. of juice polarizing 5° higher would be worth 1·54c. per gallon; and so it goes on down to the point where sugar is valued at 3c. per ℔., giving a valuation of cane juice at 1·50c., adding ·05 to every degree. I am not sure whether that table has been published by the Imperial Department of Agriculture, but I will be happy to give it as a basis which might be adopted in other colonies.

D. C. Sugar selling in Georgetown at Cents.		Price to be paid per gallon Juice. Cents.
2·00	Juice shown by polariscope to contain 1·50 ℔. cane sugar per gallon.	1·50
2·05		1·54
2·10		1·58
2·15		1·62
2·20		1·66
2 25		1·70
2·30		1·74
2·35		1·78
2·40		1·82
2·45		1·86
2·50		1·90
2·55		1·95
2·60		2·00
2·65		2·05
2·70		2·10
2·75		2·15
2·80		2·20
2·85		2·25
2·90		2·30
2·95		2·35
3·00		2·40

'For every ·05 degree that juice polarizes below 1·50 ℔. cane sugar per gallon ·05c. to be deducted from price paid, and for every ·05 degree that juice polarizes above 1·50 ℔. cane sugar per gallon ·05c. to be added to price as shown by these tables.'

This table is adopted in British Guiana, and the suspicion, which originally existed, and which is not perhaps altogether done away with in the present day amongst the labourers, is being gradually swept away, because they find that several planters of experience have taken up land near to sugar estates and are cane farming on their own account, and they are having their cane juice valued and bought by the neighbouring estates exactly as they themselves would have it done. Thus both growers and manufacturers are satisfied with the system now adopted, and I hope in a few years' time the difficulties which confronted us at the beginning will entirely disappear

and we shall see a steady improvement. There is one point in connexion with cane farming which I think you in Trinidad more or less feel, and that is, that if cane farming is carried on on an extensive scale you will be confronted with the difficulty of obtaining labour for the cultivation of your own estates. That has been a very serious matter in Demerara where rice cultivation is being taken up on a large scale, and I hope when the matter comes to be considered by the various Governments, they will see that extensive cane farming and rice growing involve the question of labour supply on the sugar estates, and will not lose sight of the important question of immigration, and the increase of the labour population.

TRINIDAD.

Professor CARMODY (Trinidad): The conditions of cane farming in Trinidad at the present time are practically the same as they were in 1900, which were described in the paper read before the Agricultural Conference in 1901. A glance at the following statistics will show that it has progressed considerably, and is now an established and important branch of the sugar industry:

CANE AND SUGAR PRODUCTION TRINIDAD.

	Total Sugar production.	Estate-grown Canes.	Cane Farmers.			
			Canes	Price paid.	Number and nationality.	
	Tons.	Tons.	Tons.	Dollars	W. I.	E. I.
1895	55,000	no return	35,000			
1896	59,000	,,	75,000			3,744
1897	55,000	,,				
1898	58,000	,,	105,000	203,000	3,824	2,326
1899	58,800	426,000	106,000	219,000	3,870	2,826
1900	46,000	361,000	106,000	228,000	3,591	2,826
1901	61,000	434,000	170,000	369,000	4,737	3,819
1902	57,830	338,000	185,000	327,000	4,850	4,506
1903	47,000	337,000	166,000	348,000	4,440	4,443
1904	48,000	385,000	172,000	360,000	4,685	4,646

The most striking features of this return are:—

(1) That nearly $1\frac{1}{2}$ million dollars have been paid for cane farmers' canes since my previous paper was read.

(2) That the yearly production since 1901 is not far short of double the production of any year previous.

(3) That the number of cane farmers has increased from 6,300 to 9,300.

(4) That the proportion of estate-grown to farmers' canes is approximately 2 to 1.

(5) That since 1901 the quantity of canes grown by cane farmers has been fairly regular, and this is a strong indication that an equal or even greater quantity may under similar conditions be relied upon for the future.

(6) That the area under cultivation by cane farmers probably exceeds 10,000 acres.

When the extremely depressed condition of the sugar industry during the period under review is taken into consideration, the progress in cane farming must be regarded as extremely satisfactory.

It may be that the progress in cane farming is the direct result of the low prices obtainable for sugar during that period; but in any case, there can be no doubt that farming came opportunely to the relief of the sugar industry of this colony at a time when, after several successive years of low prices, that industry seemed unable to hold out any longer against the unfair competition to which it was subjected.

This timely aid in the maintenance of an industry of so much importance to this colony will not be forgotten now that the price of sugar has risen to an extent which, if maintained at or near its present level, leaves no uncertainty in our minds as to the future prospects of this industry. And it is not altogether a digression to record a respectful tribute of this colony's deep gratitude to the distinguished statesman whose persistent and eventually successful efforts on behalf of the West Indies, against the unfair competition originating in national bounties and trusts that threatened the ultimate annihilation of this old-established local industry, have restored hope and confidence to the thousands of cane farmers and labourers who find congenial employment in an industry which has become by long years of association and training almost indispensable to them as a means of subsistence.

The evidence in this return is very strong in support of the view that cane farming is a system well adapted to our requirements. It must be remembered that it has sprung up under no compulsory conditions. No special legislation has been necessary, and it is creditable alike to the planters and cane farmers that the harmonious relations between them remain undisturbed.

There is evidence in it that cane farming must be remunerative to the industrious even at the prices that have been paid for canes during these years of depression, otherwise

there would be no increase in the number of cane farmers or in the quantity of canes produced by them.

And there is presumptive evidence that the farmers can be relied on to contribute a considerable proportion of the total sugar crop of the colony, for even under present conditions they are producing one-third of the total crop.

And there could be no better evidence of the soundness of the system than the fact, which is not shown in the table, that two comparatively small factories have recently ceased to make sugar, the proprietors having found it more profitable to rank as cane farmers than as manufacturers.

These are good reasons for regarding with earnest sympathy the steady growth of this new branch of a local industry in order firmly to establish it on a sounder basis; and it is more in my province to deal with this subject from the agricultural than from the financial aspect.

From one point of view we find there are four classes of farmers. Some farmers grow canes on their own land, and among these now are a few who own large areas. This is undoubtedly the best system. It is to their interest to work their lands properly and they sell their canes to the highest bidder. Others, again, rent at $5 an acre lands which do not belong to the manufacturers, and sell their canes to whichever adjacent estate offers most advantages. Of this class there are now about 350, holding from 1 acre to 5 acres each, on the St. Augustine estate, which a few years ago was bought by the Government. Another class rents lands belonging to the estate under contract to supply the canes to its factory only, and a fourth class pays no rent for estate lands but contracts to supply the factory with canes at a slightly reduced rate.

Whichever system of tenancy is considered, it must be evident that a period of land tenure so short as a year is agriculturally unsound, and it seems peculiarly inapplicable to cane which may occupy the ground advantageously for a series of years and certainly could not be limited to one year. Under present conditions it does not operate disadvantageously to the farmer, for practically he may remain in occupation as long as he pays the rent or works the land. The method of working the land has been left almost entirely to him. This may have served a useful purpose in the early stages of the industry, but any one looking round cane-farming districts cannot fail to observe a number of instances of the bad effects of this system. Cane plots may be seen which cannot give a yield of 10 tons per acre. These neglected plots distinctly show that there have been no serious attempts at tillage, or the application of manure. The return to the farmer is so small that he murmurs at its insufficiency, declares that cane farming does not pay, and spreads discontent among others as indifferent as himself. These men have not yet realized that a crop of the same kind cannot be profitably grown year after year on the same soil without the aid of pen manure regularly and freely applied at the proper time.

On the other hand, one may see plots that have evidently

been cultivated with care, well manured and certain to yield over 20 tons of rich juicy canes to the acre. It is not reasonable to believe that these good farmers would expend so much labour and manure if present conditions did not give a guarantee which practically amounts to continuous occupation of the land, which every one must admit is a necessary condition for successful cane growing. To prevent the agricultural misfortune of exhaustion of the soil, which is a risk attending the system of yearly tenancies, it seems to me desirable that the period of occupation should be extended to five or ten years and coupled with the condition--which is not unreasonable—that manure should be applied every year in stipulated quantities. This proposal would only apply to cane farmers of good standing and respectability, for we must realize, sooner or later, that bad and indifferent farmers are not a permanent factor in the system. They must gradually disappear.

Another means by which cane farmers can be assisted is by agricultural education. The colony has already done much in this direction, first in the primary schools, in every one of which agriculture is now taught with promising results; next by employing two itinerant Agricultural Instructors, and now by introducing higher agricultural education at the two colleges. It will be some years before the effects of these systems will reach cane farmers generally. But the most ready way in which useful agricultural information could be brought to the cane farmer is by establishing a scientifically conducted experiment station where the results of manures and unmanured plots, of good tillage and bad tillage, and similar object-lessons could be seen and compared, and by the widest publication of the results obtained and at what cost. Fifty acres of Government land have already been set aside for the purpose at a most convenient centre, but unforeseen accidents have, up to the present, prevented the allocation of the necessary financial aid. Of field training and experience the cane farmer has sufficient for his requirements; but something more than this knowledge of routine field work is necessary in this age of keen competition.

An important point on which the extension of cane farming must necessarily depend is the cost of transference of the canes from the field to the factory. The present cost of cutting and transmission is very great in proportion to the value of the canes; so much so that it becomes unprofitable to grow canes beyond a certain distance from the factory. Even within present short distances, it is agreed that 6s. represents the value of canes on the field and 9s. at the factory. This single item of expenditure increases the cost of the canes by 50 per cent. The profitable working of any large industry now depends so much on the cost of labour that any reducible item of this magnitude deserves most serious attention. The estate owners are doing much to reduce this cost by extending their system of railways along cane-farming districts. The Government Railway might also assist by giving special facilities to cane farmers for transmission of canes at a fixed and low rate over reasonable distance on their lines. The present usual rate is 1s. a ton on the Government Railway, which does not include

loading or unloading. It is impossible for the Railway to do much for very small farmers; but if one farmer could be selected to represent a district, so that large quantities could be regularly handled, something might be done. Cane-cutting machines and cane loaders are beginning to be used in other countries, and if they are found to work satisfactorily, their introduction here is only a question of time. At present the small cane farmer usually delivers the canes at the factory or estate railway, and so gets the benefit of the 3s. Some cane farmers cut the canes, which are then taken to the factory by estate carts at an average cost of 2s. per ton, which is equivalent to 26s. per ton of sugar.

Some other improvements of smaller importance are required in the present system of cane farming: but notwithstanding existing defects, the progress made has been very satisfactory. It is only just to the estate owners to say that this success is largely due to the facilities they have given for the use of the land near the factories at a small rental, to the generally adopted system of advance payments by them to the poorer farmers who have no capital of their own, and to the readiness with which they have accepted the canes even when they have been of inferior quality. It would be difficult to conceive any conditions more favourable than those in which both land and capital are provided to start a new industry among poor but industrious men who supply only the third requisite of production, viz., labour: and it is no less satisfactory to me to be in a position to show that the industrious men have responded in a manner which is creditable to them and to the colony. The prospects of cane farming are so bright at the present time, that if it should be my privilege to be permitted to read a further paper on the same subject at one of our future Conferences, I look forward to a magnificent record of a large extension of the system permanently established as a branch of the sugar industry and based on the co-operative efforts of the manufacturer and of an intelligent and industrious class of cane farmers.

The following paper was handed in by Mr. PETER ABEL of the Usine, St. Madeleine. It contains a few facts and figures in connexion with cane farming in the Naparima and Pointe-a-Pierre districts between 1883 and 1904:—

Cost of Farmers' Canes, 1883 to 1904.

Group I.

Year.	Tons of Canes purchased.			Cost per ton in truck on Estate.
	Tons.	cwt.	qrs.	$ c.
1883	438	0	0	4·43
1884	2.293	17	0	4·43
1885	2,769	6	2	2 83
1886	2,244	11	2	3·19
1887	5,755	11	3	3·09
1888	5,321	12	3	3·38
1889	6,622	15	3	3 12
1890	5,543	3	3	3 11
1891	5,656	11	3	3 67
1892	3,031	0	3	2 88
1893	1,524	1	1	3 10
1894	1,063	7	2	3·20
1895	2,694	2	1	3·05
1896	14.023	8	1	2 96
1897	11.491	4	0	3·09
1898	12,577	16	2	2·98
1899	14,482	11	1	3 14
1900	8,104	12	2	4·46
1901	9,858	15	1	3·43
1902	8,269	0	2	2·05
1903	10,082	3	2	3 11
1904	11,903	18	3	3·16

Cost of Farmers' Canes, 1883 to 1904.

Group II.

Year.	Tons of Canes purchased.			Cost per ton in truck on Estate.
	Tons.	cwt.	qrs.	$ c.
1883	783	3	3	4·64
1884	2,073	7	3	4·73
1885	2.311	17	0	2·93
1886	1,502	19	2	3·40
1887	3,333	18	2	3·29
1888	2,953	15	1	2·75
1889	3,000	11	0	3·34
1890	2,903	8	1	3·28
1891	1,065	0	2	3·99
1892	1.178	3	3	3·55
1893	595	12	3	3·25
1894	530	13	2	3 68
1895	899	0	0	3·14
1896	1,389	3	3	3·35
1897	2,377	6	2	2·69
1898	4,401	7	2	2 67
1899	5,066	12	3	2 60
1900	2 928	19	2	4·24
1901	4,663	13	1	3·68
1902	5,562	6	3	2·77
1903	3,386	13	0	3·25
1904	3,468	4	2	3·25

Cost of Farmers' Canes, 1883 to 1904.

Group III.

Year.	Tons of Canes purchased.			Cost per ton in truck on Estate.
	Tons.	cwt.	qrs.	$ c.
1883	...			...
1884	...			...
1885	123	17	0	2·84
1886	291	18	2	3·22
1887	352	3	3	3·07
1888	1,174	11	3	3 10
1889	2,082	0	0	3·07
1890	2,165	0	2	2·97
1891	1,887	9	3	4·00
1892	1,081	8	0	3·19
1893	392	0	2	3·29
1894	377	5	0	3·76
1895	318	4	1	3·36
1896	1,866	14	1	3·05
1897	1,322	12	0	2·82
1898	1,360	7	0	2·63
1899	965	12	3	2·93
1900	689	0	0	3·31
1901	2,234	0	3	3·07
1902	3,020	7	0	2·64
1903	9,235	5	0	2·85
1904	7,886	3	3	3·44

DAILY RECEIPTS OF FARMERS' CANES AT 14 LOADING PLACES ON 7 ESTATES FOR CROP 1904, SHOWING THE FLUCTUATIONS IN THE DELIVERIES AT THE INDIVIDUAL STATIONS AND AT THE FACTORY.

Estate Number.	1	2	3	4	5	6	7	Total.
1904.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
February 15 ..	.	.	.	. .	6	..		6
,, 16 ..	6	22	...	..	6	...	..	34
,, 17 ..	117	47	.	..	.	..	...	164
,, 18 ..	87	53	..	.	26	60	.	226
,, 19 ..	95	54	19	.	44	51	.	262
,, 20 .	118	39	34	.	57	34		282
,, 22 ...	134	127	81	..	140	54	14	580
,, 23 .	191	102	91	6	182	65	57	695
,, 24 ...	307	85	123	12	191	123	78	918
,, 25 .	256	99	140	6	195	95	127	919
,, 26 ..	207	85	106	12	125	85	97	808
,, 27 .	127	69	97	5	90	44	150	583
,, 29 .	115	79	65	..	134	49	203	646
March 1 ..	109	89	185	45	146	73	240	888
,, 2 ...	82	82	133	14	189	66	154	720
,, 3 ...	129	56	133	8	206	102	212	845
,, 4 ...	132	98	101	13	163	76	204	788
,, 5 ...	94	67	40	8	118	68	32	428
,, 7 ...	83	96	68	37	134	56	192	666
,, 8 ...	192	54	64	20	174	20	254	779

DAILY RECEIPTS OF FARMERS' CANES, ETC.—(*Contd.*)

Estate Number.			1	2	3	4	5	6	7	Total.
1904.			Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
March	9	...	172	74	92	23	174	71	211	820
,,	10	...	115	60	65	29	134	31	85	522
,,	11	..	173	82	62	34	173	51	123	698
,,	12	..	119	61	51	31	141	39	245	688
,,	14	.	134	28	24	20	77	17	137	437
,,	15	...	162	71	46	30	55	45	143	552
,,	16	.	166	73	47	36	214	36	82	654
,,	17	..	137	72	88	48	163	47	206	762
,,	18	.	325	68	65	51	170	60	259	900
,,	19	...	165	69	48	34	117	61	275	769
,,	21	..	214	107	52	13	113	23	157	679
,,	22	.	180	110	56	17	103	75	68	610
,,	23	.	224	119	68	23	247	54	258	993
,,	24	.	227	92	60	...	179	69	284	911
,,	25	...	201	69	51	...	78	63	82	545
,,	26	..	57	45	..	22	18	10	...	153
,,	28	...	...	...	6	...	...	9	...	15
,,	29	..	26	52	24	6	20	19	...	148
,,	30	...	114	86	37	19	41	40	...	337
,,	31	...	91	69	31	23	27	43	27	312
April ...	1	...	Goo	d Fr	ida	y.	...	...	...	...

DAILY RECEIPTS OF FARMERS' CANES, ETC.—(*Contd.*)

Estate Number.	1	2	3	4	5	6	7	Total
1904.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
April 2 ..	80	.	20	...	31	29	46	205
„ 4 ..	90	60	21	19	36		66	293
„ 5 .	138	50	56	15	95	40	71	466
„ 6 ..	199	80	48	31	218	74	238	888
„ 7 .	361	68	48	63	150	44	173	907
„ 8	312	83	38	37	155	81	190	896
„ 9 ..	263	99	30	54	183	54	183	867
„ 11 ...	341	91	19	251	90	49	135	976
„ 12 ..	302	74	68	175	166	60	278	1,122
„ 13 ..	129	78	38	107	158	61	239	810
„ 14 .	405	87	46	151	128	72	435	1,324
„ 15 ..	332	68	35	67	114	53	145	813
„ 16 ..	197	69	42	24	102	51	179	664
„ 18 .	205	70	33	96	83	46	201	734
„ 19 ...	169	77	40	76	102	46	166	677
„ 20 ..	258	74	35	78	133	43	426	1,047
„ 21 ...	266	93	48	150	105	68	187	916
„ 22 ...	202	68	39	191	107	50	231	888
„ 23 ...	104	48	20	66	106	32	...	374
„ 25 ...	88	59	27	18	70	22	192	476
„ 26 ...	38	30	6	0	83	11	74	248

FARMERS ON ESTATES' LANDS.

No. I.

1896.			*East Indians.*	*Creoles.*
Number of farmers	...	...	18	16
Acres of land held	...	...	56	48
Cane grown ...	...	...	70 tons	220 tons
" " per acre	...	...	4·3 "	13·7 "
" price paid in field	...	...	$1·50	

1904.			*East Indians.*	*Creoles.*
Number of farmers	..	..	160	105
Acres of land held	...	...	761	421
Cane grown ...	...	..	8,924 tons	4,256 tons
" " per acre	..	...	11·6 "	10·1 "
" price in field	...	...	$1·74	
" " at factory	...	...	$3·16	

In 1902 estates' canes fell below those of farmers' by 23 per cent., and the time lost by the factory waiting for canes was 6 per cent.

In 1903 estates' canes were less than farmers' by 76 per cent., and the time lost by the factory was 10 per cent.

Between 1900 and 1904 a large sum was spent in enlarging the factory to enable it to deal with farmers' canes.

In 1904 there were no estates' canes, and irregularity of supply lost the factory 40 per cent. of time and added that to its working expenses.

The crop of 1905 is not expected to be over one-half of the crop of 1902, and cultivation by the estate and further importations of immigrants have been resumed.

FARMERS ON ESTATES' LANDS.

No. II.

1884-5 FOR CROP 1886.

			East Indians.	*Creoles.*
Number of farmers	...	...	3	38
Acres of land held ...	...	...	3	125
Canes grown	.	...	0 tons	508 tons
" " tons per acre		...	0 "	4 "
" price in field (all taken in field) ...	...	...	$2·16	

1904.

	East Indians.	Creoles.
Number of farmers	164	235
Acres of land held	1,753	
Canes grown	8,906 tons	
„ „ tons per acre	5·08 „	
„ price in field	$1·68	
„ „ at loading stations	$2·16	
Total number of farmers from 1885 to 1904 inclusive	20,327	
Total number of acres held for 20 years ...	9,650 acres.	
„ „ „ tons of cane delivered in 20 years	55,638 tons.	
Average weight delivered per annum per acre held	5 tons 15 cwt. 1 qr.	

DISCUSSION.

The Hon. S. HENDERSON (Trinidad): In 1894, that is about ten years ago, when cane farming in this island was in its infancy, the Agricultural Society of Trinidad appointed a committee to inquire into and report upon the best means for encouraging the then struggling sugar industry. I had the honour to be the chairman of that committee. I convened a meeting of all the sugar planters in the island and one or two gentlemen who represented the interests of the cane farmers. At that meeting it was unanimously agreed that, as a means of encouraging the cane-farming industry, the sum of 6*s.* a ton should be paid to the farmers for standing canes, and 9*s.* a ton for canes delivered at the mill. The report was adopted by the Agricultural Society, and the scale of payment recommended became the current prices in the colony. That these prices were remunerative to the farmer was distinctly proved by the rapid increase in the area cultivated, which resulted last year in the cane farmers producing fully one-third of the entire sugar-production of the colony. This, on the surface, would appear to be a satisfactory state of things; but underlying it is a serious question which will affect not only the farmers but the sugar industry of the colony, and that is, the question of an adequate supply of labour. In this direction the situation has been rendered more acute year by year with the increase of cane farming. Cane farming cannot now be considered as an adjunct, but as a large competitor in the labour market with the estate owner. Mr. Abel who represents the largest interest in the sugar industry of this island has prepared a paper on the question which will be submitted for publication in the *West Indian Bulletin*. From this it will be clearly seen what effect this competition in labour is likely to produce on

the sugar estates in Trinidad. Up to 1896 a district in which I am interested produced 5,000 tons of sugar as the average output; from that year up to the present time, the output has fallen to 3,000 tons, and I confidently state that under the existing labour conditions it will scarcely be possible to raise more than that crop. Indeed, the area of sugar cultivation in this district has decreased not less than 25 per cent. On the other hand, there has been an increase in the quantity of land held by farmers. Over 1,700 acres of land belonging to the Colonial Company, Ltd., are in the hands of farmers, and Mr. Abel's return, which covers a period of twenty years, shows that the average return from those lands is only 5 tons 15 cwt. of canes per acre. It must be evident, therefore, that the prospect of the successful carrying on of cane farming in Trinidad is not encouraging. No one regrets that more than I do. Two conditions are requisite for the successful cultivation of sugar, namely, labour and an intelligent knowledge of the treatment of soil. The first affects sugar estates more than cane farming: but both are sadly wanting among the farmers. With regard to the second, I might remark that education is a force which cannot be kept under. The Government has shown a good deal of interest by introducing into the primary schools the teaching of agriculture, and I have not the least doubt that, as years go by and people come to recognize that there is something in the treatment of the soil, and that it is wrong to reap crops every year without replacing in the soil what those crops take out of it, better results will be obtained. In conclusion I must endorse the sentiments of the Hon. Mr. Howell Jones, namely, that extensive cane farming is pregnant with danger in the future unless steps are taken to provide an adequate supply of labour. To make cane farming successful in Trinidad two things are necessary: labour, and an intelligent treatment of the soil - and I may add a third, and that is, the rescue of the cane farmer from the rapacious money-lender, who is not satisfied with lending at less than 10 per cent. interest.

His Excellency Sir Henry Jackson: I should not have presumed to address such an audience on any subject connected with agriculture, but for the fact that this morning Sir Daniel Morris, in talking over the question of cane farming, told me he thought my knowledge of a system which does not at present exist in the West Indies might be of some interest to you, and possibly of some use. Among my duties in the last colony to which I was attached was the management of native affairs, which the Governor is always required to keep in his own hands. In Fiji there is native taxation amounting in round numbers to £20,000 a year, which is paid in kind, and the cultivation of cane was the easiest and best way for many of the natives to pay that tax. The fields were cultivated by the natives themselves, under the superintendence of government overseers, and the produce of the fields was handed over to the Government, who contracted with the mills for its purchase. Hence it became necessary for the Governor to make himself thoroughly acquainted with the systems obtaining throughout the country,

so as to secure the best results for the people dependent on him. In Fiji cane farming is carried on to a very considerable and rapidly increasing extent. Three systems exist there. First, the free coolies plant on their own small lots, as they do here, and sell the canes to the mill. That has not been found altogether satisfactory, for the same reasons that have made it a partial failure in Trinidad. It has led to a certain extent of overproduction, and the coolies have been unable sometimes to sell their produce, with the result of much loss and of a dangerous amount of discontent. The second system is that carried on by the large cane farmers among whom are included the native proprietors. There are a very fair number of white settlers who grow canes on areas of from 1,200 to as much as 7,000, up to nearly 10,000 acres in extent, by the use of indentured labour; and these sell their canes to the mills under contracts extending over a term of years. This system is succeeding admirably: the land is being worked to the very best advantage, and considerable fortunes are being made. But there is also a third system which does not exist here, and which to a certain extent removes some of the disabilities, which have been referred to by some of the previous speakers. In his interesting paper Professor Carmody refers to one very grave drawback, namely, that the small cane farmers do not take care of their land, manure it properly, and put back into it what they take from it, and so it falls into bad condition. Another fertile cause for complaint is that cane farming, as carried on in Trinidad, attracts labour away from the estates The other system which I shall briefly describe, is called the share system or the cane company system, and not only removes these drawbacks, but also provides for labour on the estates. This system was first introduced, I believe, in Hawaii where it has practically taken possession of the entire community. In 1902 the Commissioner of Labour of Hawaii in his annual report stated that there was only one large plantation in the Hawaiian Islands where the cane company system was not in use, and that was close to a large town, and enjoyed special advantages in the way of local labour. From Hawaii that system has spread to Mauritius, where, I am told, it is in considerable use, but I do not know precisely to what extent. The information at my disposal, however, shows that it has succeeded very well, and although it met with a great deal of opposition at first from some estate owners, they are now rapidly adopting it. It was introduced into Fiji in 1901. The figures which I shall give you were drawn up at the end of 1903, when three crops had been taken off the land and the result of the system could be fairly judged. I may mention here that the sugar industry in Fiji is practically entirely in the hands of the Colonial Sugar Refining Company of Sydney—a very large corporation which has immense refineries in Queensland, in New South Wales, and in New Zealand. It has large estates in Queensland and New South Wales, and has an output from the Fiji Islands alone which this year should reach over 60,000 tons. Every effort is being made by that company to extend the share system throughout the whole of their Fiji estates. The system consists in the

division of the estate into blocks, a block of 60 acres having been found a convenient size. That is put into the hands of a cane company, which as a rule numbers one man to every 5 acres of the block. The estate prepares the land and plants it before handing it over to the company, which then does the whole work of cultivation that is subsequently required until the cane is fit for cutting, their work being carried on under the direction and supervision of the estate. During that time they receive an advance of 1*s.* a day each, with which they are duly debited. When the cane is fit to be cut, it is reaped by a cane-gang, the transport being done by the mill by means of a system of light railways, but the cane company is debited with the cost of cutting and transport. When cut, the cane is paid for at the rate of 4*s.* a ton. I have here the actual return of a block on an estate a few miles from where I lived in Fiji, and which I know very well. The block consisted of 60 acres, and the cane company of ten men, the yield per acre was 30·7 tons, which I am sorry to see is rather in advance of the figures supplied from Trinidad. Those 30·7 tons per acre gave 1,843 tons to the block, and were paid for at the rate of 4*s.* per ton, giving £368 to the cane company. That was the gross payment by the mill to the cane company, but the latter were debited with the advances made them during cultivation, which amounted to £141 19*s.* 11*d.*; for cutting and carting the cane to the mill they were charged £66, and £8 8*s.* 11*d.* for loading and other work done by the mill. So that from their total of £368 the three preceding debits, amounting to £216 18*s.* 10*d.*, were deducted, leaving a net profit to the coolies of £151 13*s.* 2*d.*, which worked out at 1*s.* 2*d.* per diem for every day they had worked, in addition to the 1*s.* a day which they had already received. Therefore, they made 2*s.* 2*d.* a day besides what they earned in cane-gangs or as mill hands or by private work. The preparation and planting of the land by the estate worked out at 3*s.* a ton. Therefore, these 1,843 tons were put into the mill at a total cost of 7*s.* per ton – a result highly satisfactory both to the labourers and the estate. I have here a return showing the cost of each operation, but I am unable to give you the exact figures in this return, as it was given me for private use. But you who know well what the cultivation of cane means will thoroughly understand how carefully the items are worked out, when I say that in that return all the items incident to the preparation and planting of canes, such as ploughing, ridging, replanting, manuring, cost of laying tram line, transport, and cost of scoops, etc., are included. In the total cost of 7*s.* per ton, there is also included a charge for the wages advanced to the cane company, the cost of horse labour, mule labour, and bullock labour; a charge of 30*s.* an acre is made for maintenance and supervision; and there is also included a charge of 5*d.* per ton to cover cost of introduction and hospital expenses of the indentured labourers, and finally the cost of cutting and transport. It works out that the whole cost of that 60 acres to the estate was £645 7*s.* 8*d.*, and from it they got 1,843 tons of cane at 7*s.* per ton. This system was taken up by the Sugar Refining Company because they believed, from the results which it had

already given, that in course of time they would be able to work estates without indentured labour. At the expiration of two years after the introduction of the system they were able to reduce the indentured labour on one estate by more than 10 per cent. I omitted to mention that when the cane companies are formed, both free and indentured coolies are employed in them, and the experience on this particular estate to which I have referred was that the indentured coolies having once taken up the share system and found it so profitable, remained on the estate when their time had expired; they were accustomed to the work, and there was every inducement for them to settle, and the Government was applied to for grants of land for villages for these people, close to the estate, which they were glad to make because this system kept the coolie labourers in the island as contented and prosperous settlers after their term of engagement had expired. So satisfactorily has the system worked that the General Manager of the company in a recent letter stated that he looked forward to a time, not immeasurably distant, when they would be able to reduce very largely, if not entirely dispense with, indentured labour. The system has been pushed with all the strength of this great company which has never paid less than 10 per cent. dividend, and at the last meeting of the share-holders, after payment of the dividend and writing off of depreciation on the machinery, they were able to carry over £90,000 to the reserve fund. I think, therefore, that if a company of that magnitude has succeeded with a system of that sort, and when it has met with even greater success throughout Hawaii, and to a large measure in Mauritius, it is worthy of consideration whether a similar system might not to be usefully tried elsewhere. At first it was not altogether popular in Fiji, as, since the whole of the work of the cane companies is carried on under the direction and supervision of the estate, the overseers considered it gave them extra trouble, but they very soon found that the not having to measure up the tasks daily and not having to be continually driving the people to complete them made their work much easier and pleasanter. To the contention that the cane company might idle, I can only reply that the reverse has been found to be the case, as the magic of working for his own profit leads the Indian to bestir himself. A report on the working of the cane companies in Fiji by the chief manager of the Colonial Sugar Refining Company states that the coolies were doing nearly double the task per day that any indentured man ever attempts to perform.

Professor P. Carmody: I should like to ask Mr. Abel whether that unsatisfactory return of 5 tons to the acre, extending over a period of twenty years, applies to cane farmers, or what were called contractors, before the system of cane farming became fairly established. I understand that the contractors were given a certain area of land from which the plant canes had been reaped by the factory and the ratoons handed over to the contractors to keep in good order and then sell to the factory.

Mr. Abel said that only on one estate had ratoons been given out to the farmers and that was in small quantity in 1902.

The discussion on cane farming was continued on Friday, January 13.

The PRESIDENT: We have met this morning to take up one or two subjects still left on the agenda. Before we proceed with these, however, I should be glad, with your permission, to afford Mr. Henderson an opportunity for making some further remarks with regard to cane farming. It is possible that, in this matter, a little more light might tend to place the subject in a fuller and clearer manner not only before this Conference but the people of Trinidad. There is evidently some misunderstanding in regard to this question, and while not impugning the figures presented by Mr. Abel, which I believe are accurate as far as they go, we may be able to draw our own conclusions from them and make a fresh start in order to try and place the cane-farming industry in this colony on a satisfactory footing.

The Hon. S. HENDERSON: As far as I am personally concerned I would not take the trouble to refute the statements made in the newspaper article to which I have drawn your attention, but as it is probable that some of the members of the Conference live in places where misrepresentations and the imputation of base motives are not familiar methods, and may therefore accept, to some extent, the assertion that Mr. Abel and myself can scarcely be acquitted of a deliberate desire to mislead the Conference on the subject of cane farming, I deem it due to you to reply to this charge. On January 5 I took part in the discussion which followed the papers read by Mr. Howell Jones and Professor Carmody on cane farming, but in doing so I never at any time stated that 5 tons of canes was the average production per acre of cane farming in this island, nor did I give expression to the hope that it might increase 20 per cent., as I am reported to have said in the *Port-of-Spain Gazette* of January 6. I quoted certain figures from the paper presented to the Conference by Mr. Abel which showed that 5 tons 15 cwt. was the annual average production per acre from lands before referred to in the districts of Naparima and Point-a-Pièrre, and held by farmers, and the object of this quotation was to support my contention that cane farming had not accomplished what was at one time expected of it. I also expressed regret that I could not take such a sanguine view of its future as Professor Carmody did, and I stated the conditions under which alone (in my opinion) cane farming could be successfully prosecuted —first, an adequate supply of labour, which unhappily does not exist, and, second, an intelligent knowledge of the treatment of soils and of the value of manures which is not exhibited by the cane-farming class of this island. As it has also been suggested that some obscure, but of course base, motive was at the bottom of the position taken up by Mr. Abel and myself in this matter, I will at once state that my chief object in speaking on this subject was to impress on the Conference and therefore attract additional attention to the seriousness of the labour question in Trinidad. I am unable to furnish, even approximately, the acreage under cane farming in this island, but I state confidently from my knowledge of it, that the average yield of canes per acre from this source is an annually

decreasing one. It is absurd to suppose that either Mr. Abel or I desire to weaken the cane farmer in any way; what we really wish to do is to strengthen his position, if possible, by showing him that if he persists in his present methods of cane growing the inevitable result must be ruinous. I fail to see how the statements made in a letter signed 'Farmer Jones' relating to a state of things in 1895 bear at all on the cane-farming question of to-day, except to cause deep regret that such a flourishing condition does not now exist. One would think there could be little difficulty in refuting Mr. Abel's figures, if incorrect, but this has not been attempted. I think it will be admitted that no man in this island can be more safely trusted in statistical matters than Mr. Abel, and I am sure that he would not place at the disposal of this Conference a paper that was not absolutely correct.

Mr. PETER ABEL: You are perfectly right, Mr. President. The figures presented by me refer to acreage held, the greater part of which is cultivated with canes.

The PRESIDENT: You insist that it should be all in canes?

Mr. PETER ABEL: Not necessarily. Sometimes the farmers complain of canes, and they have been permitted occasionally to put one-third of the acreage in provisions. But as a matter of fact, they have not done so. You are also correct in saying that the figures were put in with the view of calling attention to the present state of the industry in order that something should be done. I stand here as a friend of the cane farmers.

Professor P. CARMODY: This discussion has, I think, arisen out of some misunderstanding: but I think it is one of those misunderstandings of which we can make use. This Conference, and the cane farmers as well, should be indebted to Mr. Abel for having brought forward those figures: because when I heard them read, although they appeared low in my mind, yet I thought we should take the matter up and see how far they applied to the whole island. Mr. Abel is very accurate in his figures, and when he puts them before the Conference, it is our duty to make use of them. On the estate with which I am connected there are 350 cane farmers, all working under the Government, and I shall ask the Government to request the manager to report how many acres are under cultivation, and we shall be able to find out from the weight of canes delivered at the factory, what is the return, and I shall be in a position in a few months to supply you with the figures. In addition to that, we shall include those figures in the returns of the Agricultural Society. If those figures show that the cane farmers are only producing 6 tons to the acre, it will be a useful argument on which to base a demand for increased cultivation: we can tell them they must increase their yield.

The PRESIDENT: You mention the acreage under cultivation. What we want to know is the number of acres actually under cane in the aggregate.

Professor CARMODY: I mean the number of acres in cane.

The PRESIDENT: Another question I should like to ask is

this—Whether a cane farmer can always keep a definite area in canes every year?

Mr. PETER ABEL: As the system is now, he cannot.

The PRESIDENT: I think what Mr. Abel has said is very important. These men hold a certain number of acres; it is, apparently, not possible for the whole of that area to be in canes in successive years. You can hardly take the number of acres held as the number of acres actually in canes. Therefore, if we want accurate returns, we must get the actual number of acres in canes by the cane farmer.

The Hon. S. HENDERSON: In other words, you want the weight of canes cut each year, and the area from which it is cut.

Mr. PETER ABEL: It will be exceedingly difficult to get that.

The PRESIDENT: That may be, but we must have some definite data on which to go.

The Rev. Dr. MORTON (Trinidad): I took a great interest in this question of cane farming and was on the committee which came to the conclusion as to the price we should pay for canes, and practically that committee's work has been the guide until now. At that time we got admirable returns from Mr. Henderson of what the cane farmers were doing, showing the exact amount of canes produced on a certain number of acres. Then, the farmers, with the assistance of their families, cultivated the land themselves, but since then the industry has undergone a change and the farmers employ their own labour. Personally, I think the former system a great deal better for the country and the people than the present, because under the present system the cane farmer, by hiring labour, became a competitor with the estate, and frequently he had not the means to pay his labourers without getting into debt. Consequently cultivation went down. At the same time many cane growers were farming land which was given them by the estate; no payment was to be made for the tenure of that land, but at the end of the year they delivered their canes at a certain price either in the field or at the mill door. Afterwards there came in those who cultivated their own land, and my impression is that they cultivated better than those who paid nothing. The estates then saw that the best thing was to rent the land to the farmer, and I think that improved the system. In dealing with a question of this kind we must make some allowance for a large number of people who are extremely hopeful and who come into the industry influenced by what is said about its being the salvation of the country and themselves. There is one duty which, I think, owners of land owe to the country and the cane farmer. It is this: to weed out the bad cane farmer and keep only those who will cultivate the land. Again, I do not think a cane farmer should be required to put his whole area in cane; some of it should be planted with other crops. I am convinced that the most profitable cane farmer is the tradesman—the artisan who gets the land, goes about in the villages and gets manure and cultivates his own land, or land he has hired and is paying for.

The PRESIDENT: I think we were informed yesterday by the manager of a large estate that he found those cane farmers who had tolerably large areas—men who were overseers on estates—were far better than the small cultivator. Dr. Morton seems to think differently.

The Rev. Dr. MORTON: I regard the small cultivator as rather competing with the estate.

The PRESIDENT: I understand that in British Guiana there are men of the overseer class that have taken up land.

The Hon. B. HOWELL JONES: Yes: and they are feeling what the larger planter is also feeling, namely, the want of labour. That is one of the points of difficulty with us.

The PRESIDENT: Would the manager of large estates regard these men as competing with him?

The Hon. B. HOWELL JONES: Not at all: they are in exactly the same box as he is.

Mr. PETER ABEL: We find here that competition is set up among the cane farmers themselves for labour. which is ruining the estates.

The PRESIDENT: But they compete in growing canes for you.

Mr. PETER ABEL: That may be so, but we have cane fields within a few yards of the railway given over to grass, while the cane farmer is taking the labour miles away.

The Hon. S. HENDERSON: What clearly proves that cane farming is not accomplishing what we wished it would is this: that the quantity of canes produced on the estates together with that produced by the cane farmer at the present time is not equal to what was produced on the estates alone in previous years: and it is all attributable to the want of labour in the colony.

The PRESIDENT: Can Professor Carmody or any one else give us some idea as to the proportion which the number of acres actually in cane cultivation bears to the total area held by the cane farmers? The area held for twenty years is 9,650 acres. What proportion of that was actually in canes, say, last year?

Mr. PETER ABEL: 1,753 acres.

The PRESIDENT: I see the number of farmers in 1904 was 164: the acreage held actually in canes was 1,753 acres; and the canes grown amounted to 8,906 tons. Dividing the yield by the actual acreage in canes, that will give an average of 5·08 tons of canes per acre. What proportion does that bear to the total number of acres in cultivation in the island?

Professor CARMODY: Granted that the average yield is 10 tons of canes, and dividing that into the tonnage produced by the cane farmers, it gives a proportion of exactly one-tenth of the total production of the island. That, of course, is only an estimate.

APPENDIX.

At a meeting of the Trinidad Agricultural Society held on Tuesday, January 31, his Excellency the Governor, Sir Henry M. Jackson, K.C.M.G., in the chair, Mr. G. C. Wyatt introduced the subject of cane farming, calling upon the society to place the industry on a more satisfactory footing. The discussion upon Mr. Wyatt's resolution was continued at a meeting of the society held on February 7, and brought to a conclusion at a later meeting on March 14.

As the discussion arose out of remarks made by members at the Agricultural Conference, and with a view to placing on record as complete information as possible, a summary of the proceedings at these meetings of the Agricultural Society, so far as they relate to points brought forward in the foregoing discussion, is included here.

The Secretary read the following covering letter in connexion with Mr. Wyatt's motion:—

Princes Town,
December 12, 1904.

To the President and Members of the Agricultural Society.

Gentlemen,—The object of this letter is not that the society should compel either farmer or planter to the observance of any set of rules, for it has no right or power to do so, but rather to invite its kindly interference in trying to bring about an understanding, the working of which will be mutually beneficial.

I know there are difficulties in the way, but I submit that there are no obstacles that cannot be sufficiently overcome to enable the cane-farming industry to be continued with mutual satisfaction. It would be positively unwise on the farmers' part to continue to plant canes as before without the positive assurance of their crop being taken off, and unreasonable of the planter to expect that of them. I do not think, therefore, that there is any serious objection on the part of the planter to come to an understanding.

I believe, rather, that he would hail with delight any arrangement that would secure to him sufficient canes to meet his estimate from year to year.

As a society, interested in the agricultural progress of the land, the farmers' claim on your consideration is very great, for they have positively enabled the planter to withstand the late crisis, and even admitting the planter's contention: 'that he has been paying the farmers more than the price of sugar justified,' yet that price was less than his own cultivation cost him; and if he lost in the purchase of the farmers' canes, his loss would have been a great deal more on the cultivation of his own canes, which would have meant a closing down of more factories with all its attendant hardships on the population.

I firmly believe that if cane farming is to proceed satisfactorily in the colony, the present is the time for action.

The price of sugar this year justifies a good increase in the price for canes, which will have the effect of causing the farmers to extend their cultivation. It is observed, though, that the planter is also extending his area of cultivation, so that unless corresponding improvement in his grinding capacity is effected, exclusion of the farmer must be apprehended; for it is unreasonable to expect that the planter will leave his own canes for the farmers' benefit, and all those interested in the prosperity of the island should do their best to see this invaluable industry on a firm basis. We are constantly told that Trinidad is a very prosperous country, but to my mind the prosperity of an agricultural country such as ours cannot be so great if the agriculturists themselves are in the terribly impecunious position of our farmers. If, therefore, Trinidad is absolutely prosperous--she is not comparatively so—some abnormal condition is at work which may at any time land us on the other side of the ledger. It is, therefore, worthy of the attention of all and every one to help in the satisfactory working of an industry which promises to be the means of laying the foundation for the permanent prosperity of the island. (See *Society Paper*, No. 16, read before this society on August 11, 1896, by the Hon. R. de Verteuil, the remarks and suggestions wherein I fully agree with, and would invite attention to on the part of any committee that may be appointed to deal with the question.)

As I have already said, there are many difficulties in the way of settlement, the reputed unreliability of the farmer being the chief: but I am of opinion that the insecurity of his position hitherto is largely accountable for his shortcomings—the securing the one contains the remedy for the other.

The above is, I think, sufficient for the society to recognize the necessity of lending its aid to bring about a mutual understanding which I suggest should be done by the appointment of a committee specially qualified to thresh out the whole question; the result of which I hope will bring about something more than mere legislation for the cash advanced to farmers, for they can never hope to obtain fair and reasonable advances until their position and responsibilities are defined and acknowledged.

Mr. Wyatt said that, as his letter had embodied all he intended to say on the motion, he would then formally move:—'That this society, recognizing that cane farmers have contributed to an appreciable extent in maintaining the sugar industry of the colony during the past years of extreme depression, is of opinion that every effort within the power of the society should be made to place cane farming on a firm, satisfactory, and permanent footing.'

Mr. Norman Lamont (now M.P. for Buteshire) rose and said: As President of the Cane Farmers' Association I rise with pleasure to second the resolution which has been so well and clearly proposed by Mr. Wyatt. I regret that I was unable, through absence from the colony, to attend the recent Agricultural Conference, as there were several things I should have liked to say, in my presidential capacity. I trust, therefore,

that this meeting will bear with me a few minutes, while I say a few words in support of the motion.

It falls into two parts: the first, 'recognizing that cane farmers have contributed to an appreciable extent in maintaining the sugar industry during the past years of extreme depression.' I think that is almost a self-evident proposition. After remaining for several years at about 105,000 tons the farmers' production jumped in 1901 to 170,000 tons, an increase which has since been maintained. Now this has been concurrent with a decrease of estate cultivation in an almost exactly corresponding ratio, since the total output remains about the same.

Now you may agree that this coincidence is purely accidental, and you may also agree that if in the four worst years the sugar industry has ever known, the farmers' output has made and maintained an increase of 70,000 tons, what would it have done in four profitable years?

The immediate future may provide the answer, especially if steps be taken in words of the motion 'to place cane farming on a firm, satisfactory, and permanent footing.' To this end action should be taken along three distinct lines. First. I advocate the adoption, generally, of a sliding scale, because until, as Mr. Wyatt said, the farmer has some definite assurance that he will receive a fair remuneration for his canes, it is idle to talk of 'a permanent footing.' I myself have done what as an individual I have been able to do, during the last few years, in the matter of a sliding scale; and in spite of many obstacles, that sliding scale, though working unevenly sometimes, has, on the whole, been a success. I do not say that it is an ideal scale, but I put it forward as a basis for discussion between members of the planting fraternity and cane farmers who are members of this society, the important point it has elicited, viz., the necessity of a minimum price. After several years' experience we found last year that it was perfectly useless to let the price go below 9*s.* per ton, because in years when we paid 8*s.* 6*d.* or 8*s.* the result had been that the farmer neglected his cultivation, which diminished the succeeding crops of cane; and therefore the new agreements which we made last year fixed a minimum price of 9*s.* The question of a maximum price also deserves consideration.

My second point is in connexion with railway extension. I suppose that in any other country in the world where the railway system is not a government monopoly, there would already have been an extension of the railway system to almost every important cane-farming centre, because the private companies would have been eager to follow up those farmers as they extend their plantations, in order to earn the large profits which were to be made by the lucrative traffic of hauling canes. The estates have done what lay in their power to provide a net-work of lines to bring in what canes those farmers around them had, but so far as any system of true connexion, connecting up the different estates and centres by means of the Trinidad Government Railway is concerned, the matter has scarcely ever been discussed or even thought of.

Now Naparima and Savana Grande have long been two very important and most anciently settled districts in the colony, and yet they pushed their railway to Tabaquite. Yet until every factory is served by the Trinidad Government Railway, there can be no real free trade for the farmer in canes —since his market is limited to donkey-distance of the nearest factory or tramway-siding. It is not that railway rates are prohibitive, for they do not compare unfavourably with those of Louisiana, where I have seen a train of farmers' canes come in from 150 miles. The charge there is 50c. per ton up to 25 miles; then 75c. up to 75 miles, the railway providing the cars. Thus, up to a distance of 15 miles our Trinidad rates are actually more favourable.

One difference of importance must be noted, viz., that the Louisiana farmer is generally a planter minus a factory, and he can quickly load a whole train with his own canes. Here it might take one of our smaller farmers several days to load a 6-ton truck; but I do not believe that this difficulty would be allowed by a sympathetic Government to stand in the way of an extension of the industry, when it could so easily be remedied by the provision of a scale at its loading-stations: while a charge of 1*d.* per load for weighing would cover interest and upkeep.

Thirdly, there is the important question of Agricultural Banks which was somewhat superficially discussed at the Conference. The present Colonial Secretary of Jamaica, when here, took a keen interest in the problem and collected data with a view to the possible introduction of a bank on the Raiffeisen system. If attempted, it must be begun on quite a small scale and with a very careful selection of men, in order to avoid the catastrophes which have befallen previous efforts in similar districts. But it must be remembered that in dealing with cane there is practically no risk, as compared with fruit or vegetables, because loans could always be recovered by sending in a note of the amount to the factory where the canes are ground to be gradualy deducted at each pay.

Such a banking system might also be the means of levelling up the cultivation methods pursued by farmers; since it would be desirable that their cultivation and crops should be *periodically inspected* and approved, before any loan could be sanctioned upon it.

I do not wish to seem to offer a panacea in what I recommend to the society. Far from it, I am only making these suggestions as a basis for future discussion. Objections are, as I well know, raised to *any* extension of the farming system, and therefore anything which may establish it more firmly is condemned as bad.

It is argued that the farmers will exhaust the land, and then throw it back on the hands of the owner. This is held by some of the truest friends of the farmers. My own experience is that the best of the cane farmers get quite as large a return as the best of the estates; and while, no doubt, a large number of them fall grievously below the standard, yet I do not

believe they really exhaust the land, because no manure at all is certainly better than the wrong manure. While if any of them really get, as is alleged, so low a return as 5¾ tons over twenty years, I regard that not as exhausting the soil, but as a sort of perpetual fallow. A few inches of the surface soil are occasionally tickled, while the subsoil is continually increasing its richness beneath. But this is very much what the estates are doing. It is conceivable that cane farming may succeed because it is cheap. It is probable that the methods of the Trinidad Estates Company may succeed because they are efficient. It is impossible that the average estates' cultivation should succeed, for it is neither cheap nor efficient.

Then it is argued that cane farming is harmful because it competes with the estates for labour. Well, it would be very strange if farmers could grow canes without labour. But I believe that those labourers whom the farmers employ bring quite as much cane to the mill, as indentured labourers working only a little over 100 days a year. And I believe that cane farming has helped us in this way-- that it has undoubtedly succeeded in keeping employed, in the production of cane, men who would have still left the estate, on their time being up, but who would have taken up the cultivation of vegetables, rice, or fruit, or become small shopkeepers.

If cane farmers compete for labour, the remedy is to be sought, not in the disparagement of their efforts, or the disarrangement of the industry, but by following the excellent example of the Trinidad Estates Company in endeavouring to economize our wasted labour in field work, and in endeavouring to fix our working population on the soil.

Gentlemen, I commend this resolution to you. This great cane-farming industry has grown up of itself. If the Government had accorded to it one tithe of the care and attention and encouragement which they have rightly given to the fruit industry, most of the difficulties to which I have referred would never have existed: others would have been overcome ere this. Even now it is not too late. The farmers have given me a notable example of what is not too frequent here—of self-help. It is on their behalf that I have ventured to detain you so long, and that I now implore you to accord to the resolution, not your grudging acquiesence, but your whole-hearted support.

The Hon. S. Henderson, in replying, remarked that Mr. Wyatt had suggested the danger of farmers' canes not being taken by the factories. He did not think the past history of cane farming quite justified that fear. As to the assertion that the farmers' canes were increasing while those of the estates decreased, he thought that was due chiefly to the fact that as farmers increased their area of cultivation, the necessity for employing labour arose, and so the farmer drew off the labour from the estates. He did not think the sliding scale would be useful either to the farmer or the planter; he thought it would create dissatisfaction. The prices of canes were regulated by supply and demand. Last year farmers got 9s. per ton, that year 12s. was offered, but it did not last long.

He thought they would all agree that there was not sufficient labour, and immigration was a *sine qua non*.

At the adjourned meeting on February 7 the discussion was taken up by Mr. George White, the Hon. G. Townsend Fenwick, C.M.G., Messrs. A. W. Rolston, R. Rust, the Rev. Dr. Morton, and others.

Mr. NORMAN LAMONT replied as follows to some of the arguments that had been brought forward against his remarks: —

I hope I may be pardoned if I speak a second time in this debate in reply to a few of the criticisms upon my speech last week, especially to Mr. Henderson's. Mr. Henderson referred to the price of canes. He disapproved of my having raised the price from 12*s* to 14*s*., and went on to say that on a previous occasion he himself had raised it from 9*s* to 10*s*. I will merely ask you to consider that if I raised the price of canes from 12*s*. to 14*s*. from motives of competition, then I must be a more foolish person than I have yet found reason to believe. If I raised the price by 2*s*. a ton, not only on the canes I got from outside, but on the larger proportion which I got from within my estate, and an adjoining estate of which my manager has also the control, on the off-chance of getting a few tons more from the outside, a chance rendered still more improbable by the fact that my neighbours were certain to raise the price too —then I wrote myself down FOOL, in very large letters indeed.

Then Mr. Henderson went on to argue that our farmers could not understand the principle of the sliding scale; though canes are purchased thus in Demerara, Porto Rico, Cuba, and at the new Gunthorpe's factory at Antigua, where I notice a minimum price of 7*s*. 6*d*. has been fixed. He is, I think, wrong in assuming that the farmers of Trinidad are any less intelligent than those of other West India Islands. I assert absolutely that our farmers understand perfectly the principle, and would accept it to-morrow.

Then with regard to the subject of the labour supply. Immigration, as an abstract proposition, may be defended in two ways: the urgent need of more labour by estates which they cannot obtain from other sources; and the urgent need of more population by the colony. Now, I admit from the first that this colony could probably support a population of one million; and, if immigration is desirable, that it would be impossible to find a more industrious, thrifty, and useful class of immigrant than the East Indian. But two questions then arise. Is it desirable, and, if so, for how long will it be so, to hasten by these artificial means, these forcing-house methods, an unnaturally rapid increase in the population of the colony, and at what point will it be better to let nature take her course? Hitherto, successive Governments of the colony have considered that the rapid methods were expedient and have therefore assisted immigration to the amount of £25,000 a year out of general revenue.

Next, certain firms and individuals conducting a particular industry maintain that their business cannot be carried on

without an annual influx of some thousands of persons, working under compulsory terms, and at a fixed wage: that though this system has been in vogue for fifty years, their need for labour is as great as ever, and that every inhabitant of the colony must for ever contribute indirectly to the cost of immigration; while everyone also engaged in the industry, great or small, must contribute directly, whether they want more labour or not.

That is the case, and merely to state it is to admit the total and hopeless failure of the present system of sugar estate management. That, after fifty years of continued immigration, the sugar estates would be no better provided with labour than they were fifty years ago, though their output has not increased, and in spite of all that science has done in invention of labour-saving devices, is a condemnation of the system too complete to need further amplification from me. And why has it failed? Because no serious attempt has been made to settle the time-expired immigrants on or around the estates, and to engage them continuously in the industry.

It is here, at this point, that the true interests of the colony and the supposed interests of the sugar planters diverge. The true interests of the colony lie, not in the least in the mere increase in a roving population, of time-expired immigrants cast adrift to make way for fresh hordes of new-comers. An increase of population is only desirable when that population is gradually settled in useful and permanent occupation of the land. And it is because the cane farmers are succeeding and because I am succeeding, in so fixing the people, in creating a real peasantry, that this outcry is raised, and endeavours are to be made to crush us by an acreage tax.

Once more I commend Mr. Wyatt's resolution to the society. Not a single argument in this debate has been adduced which has in the least upset or even shaken his fundamental proposition, that cane farming is a necessity to the stability of our industry and should be accorded every encouragement.

Instead of vainly attempting to increase your population to the extent of your cultivation, reduce your cultivation to the extent which can be worked by the population which you are able to fix on the soil; introduce every possible labour-saving contrivance; give the rest of your land—not necessarily the worst land—out to cane farmers. So may this great industry in which so many of us here are interested succeed: so may the colony prosper; and what is even more important, so will you promote not only the material but the moral improvement of the people.

At the meeting of the society held on Tuesday, March 14, the discussion was brought to a close, and Mr. Wyatt's resolution (see p. 27), being put to the vote, was agreed to.

REVIEW OF THE PRINCIPAL FUNGOID DISEASES OF THE SUGAR-CANE.

BY L. LEWTON-BRAIN, B.A., F.L.S.,

Mycologist on the staff of the Imperial Department of Agriculture.

Two, out of the three, principal fungoid diseases of sugar-cane have already been dealt with at previous Agricultural Conferences. As regards the third, I have already dealt with it frequently, both in publications and in lectures. I intend, therefore, merely to give a brief summary of the chief facts known with regard to these diseases.

RIND DISEASE.

The rind disease is one which has caused great loss in previous years to sugar-cane planters: so great was the damage in Barbados that practically every estate was obliged to abandon their then favourite cane—the Bourbon.

The fungus causing the disease (*Trichosphaeria sacchari*) gains entrance to the stem of its host by wounds - principally those caused by boring insects. It attacks and destroys the parenchymatous cells of the stem: it then passes on to the wood vessels and chokes up their cavities, so reducing the water current and causing the leaves to droop and wither. Finally, it produces spores in chambers just within the rind of the cane. The spores break through the rind and appear as small pustules on the surface of the cane. Canes badly attacked are practically valueless, while always the sugar content is reduced.

Among remedial measures there is the destruction of diseased canes. These were often separated from the healthy ones and left on one side in the estate yard, there to produce spores ready to infect the new crop. They should, of course, be burnt immediately they are brought in.

The use of only healthy canes for planting is a point on which I need not insist. The folly of planting 'seed' that is already infected with the disease is obvious.

The fungus is a wound parasite; consequently, if we keep in check the insects which are the principal cause of wounds, a good deal will be done to prevent the attacks of the fungus.

Finally we have the raising of sugar-cane varieties which are resistant to the disease. This I may say has been done, and in those islands which have abandoned the Bourbon cane, certainly in Barbados and the Northern Islands, the rind disease is no longer feared. The White Transparent is one of the best known of the resistant varieties, besides this there are several seedling canes recommended for trial on estates. In all the selection experiments resistance to rind disease is one of the points insisted upon.

PINE-APPLE DISEASE.

The pine-apple disease is caused by a fungus (*Thielaviopsis ethaceticus*) which attacks cane cuttings and prevents their growth. The fungus gains access at the cut ends or at wounds. The interior of diseased stems is found filled with a black mass of hyphae and spores of the fungus and has a distinct odour of pine-apple. The disease is one that does little damage in a good planting season, when germination and growth are rapid. During a dry season the disease does considerable harm and causes a good many cuttings to fail to germinate. The last two planting seasons in Barbados have been very favourable, consequently I have seen little of the disease.

The first means of preventing the disease is to select only sound cuttings for planting: by this I mean cuttings not only free from disease but also free from borer holes and other wounds where the fungus can gain entrance.

One other method of treatment is to soak the cuttings in some fungicide, by this means protecting the cut ends from infection. As this is a subject which is to come up for separate discussion I will not say anything of the experiments which have been carried out on these lines.

ROOT DISEASE.

Root disease of the sugar-cane is caused by a Bacidiomycetous fungus (*Marasmius sacchari*) : the same fungus attacks sugar-cane in Java, while another species of the genus attacks bananas in the West Indies (*M. semiustus*). The disease is one that has caused great loss in Barbados, especially in the season before last when weather conditions were unfavourable to the growth of the cane.

The symptoms are first those of a deficient water supply. The leaves roll up and finally become dry and wither, the tips and edges showing the effect first. Fewer leaves, also, are developed. The lower leaf-sheaths, instead of falling off leaving the stem clean, remain attached, and when examined are found to be matted together by a white mycelium, and the whole has a characteristic musty smell. The young roots when examined are seen not to be developing properly, the tips are red and black and they remain short. The stools, generally, are dwarfed and easily uprooted. The last stage is the development of toad-stools ; these are found, usually in rainy weather and in the early morning, at the base of the attacked stools ; they are small, white, delicate structures, bearing the spores on gills on the under side of the cap. They may spring direct from diseased roots or from the matted leaf-sheaths. The following is a technical description of the genus *Marasmius* and the species *M. sacchari* :—

'Marasmius, Fries.—Tough, thin, dry, reviving their form when moistened (not putrescent). Veil absent (except in one sp.) ; stem cartilaginous or horny ; gills tough, sub-distant or distant, often connected by veins, edge acute ; spores white or pallid.

'Marasmius sacchari, Wakker, *De Ziekten van het Suikerriet op Java*, p. 194, pl. V. (1898).—Gregarious or fasciculate at the

base, variable, flesh membranaceous, persistent; pileus white, broadly campanulate, then dingy white and plane or cup-shaped, 15 mm. diam.; gills white, simple, or bifurcate; stem central, white, 15 mm. long, apex tubiform, base villous, hyphae white; spores hyaline, continuous, irregularly oblong, ends attenuated, rounded, 16-20 × 4-5 micro millimetres.' (Massee: *Text-book of Plant Diseases*, p. 387.)

The fungus is a facultative saprophyte and its mycelium is capable of living indefinitely on decaying cane-stumps, so long as conditions are favourable, that is, in the absence of much air and light. It attacks the cane plant indirectly, first developing on the dead leaves, dead roots, etc., and finally attacking the root tips. Here it destroys the growing region and so prevents root development.

Under favourable conditions the sugar-cane is capable, to a great extent, of overcoming the attacks of Marasmius. It is only when root development is checked that great damage is done.

The fungus spreads by its spores but mainly by its underground mycelium, spreading thus from diseased plants to healthy ones in the neighbourhood. This gives us one way of checking its spread, namely, by digging a trench around an attacked area. The trench should be about 18 inches deep and should include one or two rows of apparently healthy canes.

Good cultivation, by promoting root development and admitting light and air, will also check the growth of the fungus. Diseased canes should not be allowed to ratoon, for it is as ratoons that canes are most severely attacked. Whenever possible infected land should be rested from cane cultivation for at least two years. Cotton forms a good rotation crop.

Old cane stumps infested with the mycelium of Marasmius are a frequent source of infection. These should be dug out and destroyed. Another point is to use only very healthy, vigorous cuttings, to give the plants a good start. Sometimes, even now, cuttings are taken from plants which are too poor to be crushed; the folly of this, in giving the fungus a good start with the new crop, is obvious. Great care should also be taken in supplying to use only healthy plants.

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DISCUSSION.

The PRESIDENT: Three principal diseases have been touched on by Mr. Lewton-Brain, the first is the rind fungus. This is a disease which a few years ago attacked the Bourbon cane in Barbados, and led to the abandonment of that cane owing to its susceptibility to the disease. I would submit for the opinion of the Conference whether the rind fungus is now prevalent in the West Indies, and whether it is found on any other cane than the Bourbon, and to what extent?

The Hon. B. HOWELL JONES (British Guiana): Rind fungus is extremely prevalent in British Guiana chiefly on the Bourbon cane. White Transparent has also been attacked by it. On one estate, Anna Regina, so bad was the attack that, but for the seedling canes being mixed with the Bourbon, we would not have been able to make any sugar this year. There has been no sign of the pine-apple disease.

Mr. J. R. BOVELL (Barbados): In Barbados the rind fungus is practically confined to the Bourbon cane. With regard to the root fungus, I am sorry to say that, up to a couple of years ago, there was a great deal of it, and I should like to emphasize Mr. Lewton-Brain's remarks as to the care planters should take in the selection of cane plants, and in rejecting any plant which shows signs of disease.

Dr. FRANCIS WATTS (Leeward Islands): At one time it appeared that the sugar industry in the Leeward Islands would have to be abandoned owing to the attacks of rind fungus. The cane then grown was the Bourbon. Experiments were carried on in the hope of raising a variety of cane more resistant to the disease. Many varieties tried in the early stage had to be abandoned because they were as badly attacked as the Bourbon: among these was the Lahaina cane. We have, however, succeeded in obtaining varieties of canes (among them B. 147) highly resistant and practically immune, and rind fungus has almost entirely disappeared from Antigua and St. Kitt's. Root disease has been observed in Antigua to a certain extent especially where the soils are somewhat heavy, and also in St. Kitt's: but in the latter island I know of no case where it has become a pest.

The Hon. S. HENDERSON (Trinidad): The rind fungus made its appearance in Trinidad in 1891, and although it did not appear to have any appreciable effect upon the crop then about to be reaped, yet it was sufficiently serious to cause planters to take measures to get rid of it. The measures adopted were the cutting out of the stems, removing them from the field and burning them. The stems were not crushed before they were burned. That was done for two or three years, after which the fungus became less harmful. The cane then planted was the Bourbon, but in some districts this is giving way to the White Transparent, which has been found to resist the disease better than the Bourbon. I remember seeing only one variety of seedling cane badly attacked by rind fungus in 1898, and that was the Burke cane.

The Hon. W. FAWCETT (Jamaica): I am glad to say we are

not troubled very much with diseases of cane in Jamaica. Some two years ago the whole of the canes on an estate in the centre of the island were swept off by both rind and root fungus. Since then, although we see evidence of diseases here and there, they have not given serious trouble.

Mr. E. M. DEFREITAS (Grenada): My experience is very small, but there is a remarkable instance with reference to the Bourbon cane and rind fungus. I had a field of B. 147 which I planted on the recommendation of the Imperial Department of Agriculture. Alongside of that was a field of Bourbon. B. 147 did so well that I invited a neighbouring planter interested in the sugar industry to see the field. Then the Bourbon was also looking well. Six months after the Bourbon was attacked by rind fungus, and there was not a sound cane left in the field, whereas B. 147 was not attacked at all. B. 147 has done so well in Grenada that the plants are now at a premium. This will be the fifth crop reaped from the original field. The canes have not been attacked by disease of any kind.

Mr. G. S. EVELYN (Barbados): I should like to ask whether we can account for the sudden outbreak of the rind fungus in Barbados in 1895 or thereabouts.

The PRESIDENT: In the case of a disease so widely spread, it may be that it had existed among the canes for a long period, but only came into prominence when the canes were weakened and not in good health, due to unfavourable conditions.

Dr. VAN HALL (Surinam): We are happily not very much troubled with sugar-cane diseases in Surinam. Rind fungus is there, but it does not do serious damage. Land is cheap, and the proprietors are constantly changing their acreage, and when rind disease appears in any field, that field is at once abandoned and another piece of land taken into cultivation. The Bourbon is the only cane planted there. Professor Harrison very kindly sent me this year some seedling varieties, and they have just been planted out.

REVIEW OF THE INSECT PESTS AFFECTING THE SUGAR-CANE.

BY H. A. BALLOU, B.Sc.,

Entomologist on the staff of the Imperial Department of Agriculture.

At the previous Conferences there have been presented papers on this subject, which, together with such other information as has come to hand from time to time, have appeared in the publications of the Imperial Department of Agriculture. This paper is intended to furnish a concise

summary of what has been published, together with an account of a borer in canes (*Castnia licus*) which has recently appeared in British Guiana.

THE MOTH BORER.

(*Diatraea saccharalis.*)

Life-history.—The egg is laid on the leaf; the larva lives about ten days in the outer leaf-sheath and then bores into the heart of the plant which, later, withers and dies. These withered shoots are known as dead hearts and are an indication of the presence of the larvae in a stool of canes. The larvae in a shoot may become well developed before the shoot withers; they also penetrate the stem of the cane, and may go from one shoot to another in the same stool. The larval life lasts from thirty to thirty-five days.

The pupa is formed in the tunnel made by the larva, near the surface of the cane, protected by a slight web across the mouth of the tunnel. The pupal period lasts about six days. The imago has a short existence, living but a few days. It is not a strong flyer, and remains inactive by day, flying at night. The female lays from 100 to 300 eggs.

Description.—The egg is flattened, oval, slightly convex, upper surface finely reticulate. The eggs are laid in clusters averaging about nineteen to a cluster, the range being from four to fifty-seven, usually between ten and thirty. When first laid they are light-yellow, becoming orange-brown later, and just before hatching the centres become very dark. The egg is about 1 mm. ($\frac{1}{25}$ inch) in length.

The larva is about 2 mm. ($\frac{1}{12}$ inch) in length when first hatched, of a light-orange colour, with numerous short, black hairs. The mature larva is about $1\frac{1}{8}$ inches in length, the head is dark-brown or black, with a V-shaped mark lighter than the rest of the head. The pronotum is dark-brown or black. The remainder of the body whitish with stigmata black, and with a few dark hairs scattered over the body. The head and pronotum are hard, the remainder of the body being soft.

The pupa is naked, shiny brown, $\frac{1}{2}$ to $\frac{3}{4}$ inch in length, with short spines and callosities on abdominal segments.

The imago or moth is of a dull straw colour on upper surface of fore wings, with a few dark spots; the hind wings are whitish, under surface of wings uniformly light, the body brownish. The expanse of wings is $1\frac{1}{8}$ to $1\frac{3}{8}$ inches, length of body $\frac{5}{8}$ to $\frac{3}{4}$ inch.

Parasites.—The eggs are attacked by a small hymenopterous parasite (*Trichogramma pretiosa*), and the larvae are sometimes attacked by a fungus (*Cordyceps barberi*).

Injury to Canes.—The moth borer injures the cane in several ways; by killing the young shoots; by eating out the sugar-containing portion of the stem; and by affording easy access to fungoid diseases, especially the rind disease (*Trichosphœria sacchari*).

Prevention.—Canes that show borer holes should not be planted, nor should such canes be sent from one estate or from one colony to another.

Remedies.—Cutting out the dead hearts seems to be the most generally practised of all remedial measures. These should be cut as low as possible to ensure getting below the larvae. The dead hearts are burned or fed to stock, and the larvae are thus destroyed. The collecting of eggs has been practised but does not seem to be generally carried out in the West Indies. Care should be taken to distinguish those eggs containing parasites: parasitized eggs should not be burned with the others, but should be kept to give the parasites an opportunity of emerging.

HARD BACK.

(*Ligyrus tumulosus.*)

This is the common black hard back, the larva of which is a white grub living in the ground feeding on vegetable matter. There seems to be no evidence that this is a serious pest to sugar-cane, but a closely related species, *Ligyrus rugiceps*, is a pest of canes in Louisiana, and the West Indian form may do more harm than has been realized.

THE WEEVIL BORER.

(*Sphenophorus sericeus.*)

Life-history.—The eggs are laid singly, embedded in the cane to a depth of $\frac{1}{6}$ inch. The egg hatches in four days, and the larva or grub eats its way into the cane, forming a small tunnel which increases in size as the larva grows larger. The larval period or grub stage lasts about seven weeks. During this period the larva destroys most of the interior of a joint of cane. The pupa is formed in the tunnel made by the larva and is covered with a large, rough cocoon made of the fibres of the cane. The pupal period lasts about ten days, and at the end of that time the adult beetle emerges from one end of the cocoon. The beetle is active, flying about at night. The female, after mating, begins egg-laying which continues for some time. The beetles may be kept alive several weeks.

Description.—The egg is oval, about $\frac{1}{15}$ inch in length, and is nearly transparent.

The larva is a small, white grub when first hatched. It has no legs but has a hump near the hind end of the body by means of which it pushes itself along the tunnel. When full-grown the larva is about $\frac{1}{2}$-$\frac{5}{8}$ inch in length and $\frac{3}{8}$ inch in thickness at the swollen part of the hind body.

The pupa is soft, whitish, enclosed in a rough cocoon of coarse fibres in the rotten cane where the larva has lived.

The adult beetle is reddish-brown with black markings. There are three longitudinal black marks on the thorax, and the wing covers are edged with black, and on each wing cover there is a black line and black spot. The front of the head is produced to form a stout beak or snout. The length is about $\frac{1}{2}$ inch, the width about $\frac{3}{16}$ inch.

Injury to Canes.—The damage caused by this insect consists in the destruction of canes growing in the field, injury to young canes springing from cane plants, and possible injury to young canes springing from cane stumps.

Remedies and Prevention.—Destroy all infested canes, cover cut ends of cane plants, cane tops, and ratoon stumps with mould as soon as possible, or plant so that no ends shall be left exposed above ground, and destroy all stumps not intended for ratooning as soon as possible after canes are cut. Tarring the ends of cane plants, as recommended for preventing fungoid attack, would probably be useful.

THE ROOT BORER.

(*Diaprepes abbreviatus.*)

Life-history.—Eggs are laid in clusters ranging in number from eight to 130 on upper side of leaf, not necessarily that of a food plant. When first laid, the eggs are white; later they become tinged with yellowish-brown. The eggs hatch in ten days. The newly hatched larva is about $\frac{1}{16}$ inch in length, pale yellowish-brown in colour. There are no legs, and the body is not swollen to form a hump like that seen in the larva of the weevil borer. The larvae or grubs fall to the ground and burrow beneath the surface. They begin feeding almost immediately on the roots of plants. They attack the canes first at the soft ends of the adventitious roots, the root stock being attacked later. The larva enters the cane about 9 to 11 inches below the surface of the ground, works its way upward several inches, then turns and descends and enters another cane. 'One grub is often responsible for the death of a whole stool of canes.'

The larval period extends over 300 to 312 days, and the mature larva measures $\frac{7}{8}$ to 1 inch in length, and $\frac{5}{16}$ to $\frac{3}{8}$ inch in diameter.

The pupa is formed in the ground where it is enclosed in an earthen cell, 6 or 8 inches below the surface or in the cane, in which case it is enclosed in a cocoon similar to, but rougher than, that of the weevil borer, or in a nest of decaying leaves. The pupal period is about fifteen days.

The imago or adult beetle is at first soft and brownish-white. In two or three days it becomes hard and assumes its characteristic colours. The thorax is brownish with fine white pubescence, which gives a spotted appearance, wing covers greenish white with longitudinal brownish or bronze stripes; head brownish with stout snout or beak, the legs brownish, femora somewhat swollen.

The length of life of the adult is about twenty days, during which time mating and egg-laying occur. The female lays about 240 to 270 eggs.

Food Plants.—This insect is probably a very general feeder. It is known to feed on sugar-cane, sweet potato, guinea corn, imphee, and ground nut, and has been found eating the roots of cacao trees in St. Lucia. (See *Agricultural News*, Vol. III, p. 264.)

Remedies.—Sweet potatos and imphee should not follow canes in field culture, nor should these be followed by canes

A crop not attacked by the root borer would be advisable, or no crop, with the removal of the cane stumps. The larvae of the root borer can live only about fifteen days without food, and to deprive them of food will be greatly to reduce their numbers. The following plants do not seem to be attacked by the root borer: ochro. cassava, yams, and eddoes, woolly pyrol, pigeon peas, bonavist, rouncival pea, bean.

THE CANE FLY.

(*Delphax saccharivora.*)

This small insect, although at one time believed to be a very severe pest, is not now considered as such, though generally present in small numbers each year. It appears to be well controlled by the lady-bird beetles (*Coccinellidae*) and the lace wing (*Chrysopa* sp.) except for occasional outbreaks on small areas. The presence of *Delphax* is generally indicated by black blight.

SCALE INSECTS.

Three species of scale insects are known to attack canes in the West Indies, viz., *Dactylopius sacchari*, *Dactylopius calceolariae*, and *Aspidiotus sacchari*.

These species of *Dactylopius* are 'mealy bugs,' soft-bodied insects covered with mealy wax. They attack the stems and are protected by the leaf-sheaths. *Aspidiotus sacchari* is a small, rounded, straw-coloured scale insect. These insects do but little harm, probably, and in the time ordinarily required for the growth of the crop would not become very numerous. No treatment is practicable except the exercise of great care not to plant infested canes.

THE SHOT BORER.

(*Xyleborus perforans*)

This is a small, brownish beetle about $\frac{1}{10}$ inch in length. The greatest injury to canes from the boring of this insect is that the holes in the hard rind of the cane furnish an easy entrance for fungoid diseases such as the rind disease. As the species of *Xyleborus* readily attack dead and dying plants and multiply in them rapidly, the prompt destruction of dead and dying canes will have the effect of reducing the number of shot borer and checking its development and spread. The shot borer has not been prevalent in the West Indies for the past two years.

THE LARGER MOTH BORER.

(*Castnia licus*, Drury.)

This insect was first reported to the Imperial Department of Agriculture in October 1904 from plantation Enmore, British Guiana, where it was then causing serious injury to the canes.

Mr. Bethune, manager at Enmore, sent specimens of the larval and adult forms of the insect as well as pieces of cane and a stool of cane stumps showing the damage done, accompanied by statements as to its destructiveness. The Executive

Secretary of the British Guiana Board of Agriculture forwarded a report by Mr. Ward, Agricultural Instructor, and further specimens accompanied this report.

From such correspondence and reports, and the specimens and material received, this paper has been prepared, the writer having had no opportunity of studying the insect in the field.

The egg is about 4 mm. ($\frac{1}{6}$ inch) in length and 1 mm. ($\frac{1}{25}$ inch) in width, spindle shaped, tapering to a point at either end, with five prominent longitudinal ribs from end to end. The colour ranges from a light-gray (nearly white) to a dark-gray. Eggs laid in captivity hatch in three or four days. Eggs have not been found in the field, and it is not known where they are laid. In captivity the eggs are laid singly and unattached.

The newly hatched larva (in captivity) is large in comparison with the size of the egg. Full-grown larvae are about $2\frac{1}{2}$ inches long and $\frac{1}{2}$ inch in diameter. The head is large, reddish-brown in colour, with large powerful mandibles, with which it eats its way through the canes. The mandibles are shiny-black. The segments of the thorax are the largest, thus giving the body its greatest size just behind the head. The abdominal segments are nearly uniform in size decreasing gradually posteriorly, the last one being the smallest.

The thoracic legs are small, brownish, situated on the large fleshy swellings of the three segments of the thorax. The abdominal legs are soft protuberances on the third, fourth, fifth, sixth, and last abdominal segments. All the body segments are swollen and prominent. The colour of the larva is whitish; the spiracles are very prominent, being large, and brown in colour. There are a few pale hairs most plainly seen on the head, on the last abdominal segment, and on each segment below the line of the spiracles. The skin is shiny and slightly transparent.

On the dorsal surface of each of the second and third thoracic and the first seven abdominal segments, there is a small area set with short, brown spines or callosities, which serve to assist the larva in travelling along the tunnel in the cane.

The pupa is formed either in the canes at the base of the stool or in the ground near the canes. The pupa is brown in colour about $1\frac{1}{2}$ inches in length. The wing pads, antennae, and proboscis are very plainly visible. On the dorsal area of each of the abdominal segments, except the last, are spines and thickened processes. On the first six segments there are two rows and on the seventh and eighth there is one row across the segment. These spines are short, sharp and directed backward, and assist the pupa in wriggling its way either through the tunnel in the cane toward the top of the stump or through the ground toward the surface when the adult or imago is about to emerge. The pupa is sometimes enclosed in a rough cocoon formed of the fibres of the cane and sometimes in an earthen cell. (I have not seen a cocoon and only one pupa—that one, an imperfect one.)

The imago has a spread of wings of 3 to $3\frac{1}{4}$ inches. The

body is $1\frac{1}{4}$ to $1\frac{3}{8}$ inches long. The colour is dark, brownish-gray, lighter beneath.

The fore wing is crossed on the upper surface by a broad white band just within the middle: outside this and nearly parallel with it a short white band extends from the front margin about half-way across. These white bands are seen on the under side of the fore wing also. Along the outer margin is a row of small, light spots which are not conspicuous.

The hind wing has a white band on the upper surface running across it near the middle. This is interrupted, near the front margin, making two distinct spots, behind which the band gradually increases in width until near the hind margin, where it is at its widest. A corresponding white band is seen on the under surface of the hind wing, but it is narrower, and the two spots near its beginning are less distinctly separated. Along the outer margin of the hind wing above are six spots of pale orange, the first three smaller and less distinct than the last three.

The head is large, with large, prominent eyes of a dark, velvety-brown colour. The antennae are slender, swollen toward the end, tipped with a small, slightly curved point, dark-brown in colour, lighter at the tip. The proboscis is slender, light-brown in colour, about $\frac{1}{2}$ inch in length, coiled under the head when not extended for feeding, etc.

The body is robust, clothed with coarse scales which are long and hair-like at the anal end. Colour, similar to the wings, dark-brown above, paler below.

Habits.—The eggs are laid (in captivity) singly and not attached. It is not known where they are deposited in the field, but it is suggested that they may be laid in the axils of the leaves, or in the ground at the base of the plant.

The larva enters the cane at the base of the plant and tunnels upwards about 2 feet and then turns and goes back through the same tunnel and bores its way into the underground part of the plant. Canes have been found in which the larvae evidently entered high up on the plant and worked their way downward, but such exceptions are rare.

It is not known how long a time is required for the growth of the larva from the hatching of the egg to the forming of the pupa. Only one larva has been found in a cane, and it is likely that one larva attacks more than one cane, perhaps all the canes in a stool, as in some cases the underground stems are all tunnelled through, so that all the tunnels in the stems of a stool are connected. In some cases, too, the underground stems are eaten through at the sides, so that the tunnels connect with the soil around the plant. It is not known whether the larva tunnels underground from one stool of canes to another, but it seems likely. Larvae in captivity in the laboratory of the Imperial Department of Agriculture tunnelled through and through the soil in a glass dish in which they were kept. The soil was 6 inches deep and the larvae went to the bottom of the dish, and the tunnels penetrated in all directions through the soil.

The duration of the pupal stage is not known, nor is it known whether the adult feeds at all after emerging from the pupa. The adult or imago is a day-flying moth, greatly resembling a butterfly in its general appearance.

The damage to the canes is of two kinds. The larva eats out a large amount of the sugar-containing portion of the cane, and so thoroughly tunnels the stumps and underground portions that it is impossible to get ratoons from them.

Occurrence.—The larger moth borer has been known at plantation Enmore for the past three years, but has not occurred in seriously large numbers until the present season (1904). The moths have been most abundant in January and February in previous years, and a few have been seen in May or June, following a mid-year cutting of canes.

As the specimens received from British Guiana appeared to be identical with some large caterpillars received some years ago from Marienburg estate in Surinam, a letter of inquiry was sent to Dr. C. J. van Hall, Director of Agriculture for the Dutch West Indies, asking for particulars as to the outbreak in Surinam. Dr. van Hall wrote that the description of the pest corresponded with a pest of canes known at Marienburg some five or six years previously. 'The pest appeared suddenly and assumed a dangerous character, but very soon the borers disappeared and so far as we know, they have not been seen here any more.' Early in 1903 a large lepidopterous insect was sent to the Head Office from Trinidad, which was said to be a borer in bananas. The specimen was very badly injured and was not identified, but it is believed to be the same as the one under discussion.

Remedies.—Several remedies have been suggested, but only two have been tried. These are (1) catching the adult, while flying, with nets, and (2) plugging the borer holes in the top of the cane stumps with clay to prevent the emergence of the adult. By the first of these methods large numbers of the moths were caught by coolie children at plantation Enmore. The second seems not to be very efficient, as the clay crumbles in the sun and opportunity is thus provided for the escape of the moths. Carbon bisulphide is not available in British Guiana, or it might be possible to make use of this valuable insecticide. The moths have not been observed to feed on any flowers, nor will they feed on sweets provided them in captivity. If they were attracted to any food, use might be made of poisoned baits.

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Watson: Root Borer of Sugar-cane: *West Indian Bulletin*, Vol. IV. p. 37.

Maxwell-Lefroy: Insect Pests of Sugar-cane: *West Indian Bulletin*, Vol. II, p. 41.

ADDENDA.

Since the preparation of the foregoing account of the cane borer at plantation Enmore, British Guiana, for the Agricultural Conference, the following additional information has been obtained :—

Dr. L. O. Howard, Chief of the Bureau of Entomology, U.S. Department of Agriculture, Washington, D.C, writing under date of December 17, 1904, to the Imperial Commissioner of Agriculture, with reference to the specimens sent to him, says: 'This is *Castnia licus*, Drury, which has been reported as being bred from Orchidearum on the Upper Orinoco. It has been collected in Brazil, Ecuador, Demerara, Surinam, Trinidad, Upper Orinoco, Nicaragua, and Costa Rica, and is described and figured (in part) in Westwood's 'Monograph of the Castniidae,' *Transactions of the Linnean Society.*'

The *Journal of the Trinidad Field Naturalists' Club*, Vol. I, no. 6, p. 141, February 1893, contains an article entitled 'Castnia licus: A Banana pest,' by Mr. Thomas J. Potter, which is quoted here in full :—

'When the peasant cultivators in my district see a banana tree backward in growth, they say that it is the worm which always attacks the banana sucker when planted at a "bad moon." On May 15, I resolved to find out what this worm was, and examining a sucker that was in a backward state I discovered traces of a boring insect which had entered at the base of the sucker and almost on a level with the soil. It had bored upwards almost into the heart of the plant, and the channels it had made were filled with decomposed vegetable matter. I did not succeed in finding the insect, but traces of its recent presence were unmistakable. A few days after this, I inspected another plant in a condition similar to the last one. Again I was unsuccessful in discovering the culprit, for it had evidently bored through the root stock and emerged from the plant. On a more recent occasion I examined another affected plant and this time was successful in capturing a specimen of the borer. I found it was the larva of some lepidopterous insect, about 3 inches long, and about $\frac{3}{8}$ inch in diameter. Its head was light-brown, with darker-brown mandibles and its body was whitish with a transparent skin. Its presence in the plant is readily indicated in the early stages of its attack by an exudation of a transparent mucilaginous fluid from the hole through which it effects an entrance. The only cure I have tried is to destroy the insect and to cut out the affected part when the enemy makes its first attack, but nothing can save a plant which has been affected for some time. On July 10, 1892, I found a caterpillar boring into a banana sucker; on August 18, it spun a cocoon and changed into a mahogany-brown chrysalis, and on September 24, a fine specimen of the *Castnia licus* emerged. This moth flies in the day and I have often caught it in banana patches, but I little dreamt that it did such harm to the plants in its early stages. A short time afterwards I observed one of these moths depositing its eggs. It selected the base of a banana sucker for this purpose, and laid a single

egg just inside a dry and withered leaf-stalk. The local name of this moth is "cane-sucker."'

Mr. A. W. Bartlett, Executive Secretary of the British Guiana Board of Agriculture, writing under date of February 4, 1905, furnishes the following additional information: –

'In reply to your questions with regard to certain points in the life-history and habits of this insect, the following additional information has been obtained:—

'(*a.*) The eggs are laid singly on the cut surface of a cane stump apparently almost immediately after the emergence of the insect from the cane stool, and it would seem probable that the larva bores its way into the cane stool within three days after the egg is deposited.

'(*b.*) The length of time spent in the larval state is unknown. The grubs hatched out in captivity have lived but a few hours, and most of the larvae found at this season are practically fully fed.

'(*c.*) Some cocoons are found in the underground portion of the cane while a few make earthen cocoons below the cane stool. The duration of pupation remains undetermined. The pupa works its way up the hole bored in the stump preparatory to the emergence of the imago by means of a fringe of sharp spines round its posterior segments. In one instance the insect emerged from a piece of cane stool planted in a pot of damp cocoa-nut fibre, not by means of the top end of the cane stump, but from below through the fibre.

'(*d.*) The length of life of the adult is unknown.

'(*e.*) With regard to the feeding habits of the adult, it does not appear that it is attracted by any shrub or flower, and it is seldom seen to alight on any of the grasses.

'(*f.*) It has been recorded that, so far as it is known, the larvae feed chiefly on *Orchidaceae* and *Bromeliaceae.*

'(*g.*) As many as three fully-fed larvae are sometimes found in one cane stool which is seldom forsaken until it is completely riddled. Owing to the comparatively short distance between the cane stools in the rows it is quite possible that the grubs work their way from one to another.

'(*h.*) The borer cannot be detected by the appearance of the cane in the early stages of the attack. In most cases it is not destroyed by cutting out the young canes, as is the moth borer, for when the leaves begin to wither the insect has again descended to the stool to extend its tunnelling into another cane. Hence it is difficult to combat successfully with this grub.

'The remedy of plugging the holes in the cane stools suggested by the Entomologist of the Imperial Department appeared at first to be attended with partial success as the number of the adults flying in the plots treated after this manner was reduced. Clay, however, crumbles when exposed to the weather and egress is again permitted.

'As many as possible of the adults are still being captured. The insects appeared during the first week in November and

since then there has been a steady increase in the number collected weekly, rising to close upon 17,000 during the week ending December 31, 1904.

'When supplying gaps in the cane fields the dead stools are removed and in this manner a good many grubs are taken.

'The insect has since been identified in London as one of the day-flying moths belonging to the family Castniidae and known as *Castnia Berbece*. So far as is known the larvae feed chiefly on *Orchidaceae* and *Bromeliaceae*.'

DISCUSSION.

Mr. A. W. BARTLETT (British Guiana): I do not know much about the new cane pest at Demerara beyond what Mr. Ballou has told us. I saw the manager at plantation Enmore before I started and he told me that it was still troublesome. He endeavoured to keep it down by employing coolie boys to catch the moths. The pest has not appeared in any of the neighbouring estates, but Professor Harrison says he has seen it in different parts of the colony.

The Hon. B. HOWELL JONES (British Guiana): No one who has not visited Enmore would have any idea of the vast injury that is done to the estate. This pest was discovered in one field. At first little or no attention was paid to it, but soon it became a very serious pest. The moths come up about mid-day and fly about until 3 o'clock in the afternoon. The pest is not now confined to that one field but has spread to a considerable distance over the estate. As to the origin of the disease nothing so far has been discovered.

The PRESIDENT: Can Mr. Ballou add anything as to the life-history of the pest?

Mr. BALLOU: I have no definite information. I have now in the breeding cage in the laboratory some larvae received on October 22: they were nearly fully grown; they left the pieces of cane in which they were feeding, and were then placed in a jar containing some earth; they tunnelled through the earth but did not pupate. They still seem very active. Some of them are not feeding at all. The eggs are laid singly and loose, and not attached to anything. I believe Mr. Bethune discovered that the moth lays its eggs either in the ground or against a plant on the surface of the ground. The egg hatches and the larva makes its way into the cane. I suggested that the feeding habit of the adult might be carefully studied, but Mr. Bethune has written to say that he had been unable to find any actually feeding.

FIELD TREATMENT OF CANE TOPS FOR PLANTING PURPOSES.

Dr. FRANCIS WATTS (Leeward Islands): Acting on the suggestion of Mr. A. Howard, late Mycologist of the Imperial Department of Agriculture for the West Indies, we have treated plant tops and cuttings with germicides before planting. The germicides used have been Bordeaux mixture and tar, separately and combined. Experiments have been conducted on tops and on cuttings; by the latter we mean the lower joints of the cane not usually used for planting. The results of the experiments carried out during the season 1902-3 have already been published in the *West Indian Bulletin* (Vol. V, pp. 96-103).

The results go to show that the treatment with germicides prevents the decay of the top or cutting prior to the formation of roots and the development of the shoot from the bud. When tops are used and the planting season is propitious, the loss from this decay is but small, and germicides have but little influence; but when the season is unpropitious, or when cuttings are used, the loss from this cause may be very great, so that germicides are particularly useful when cuttings are used or when the planting season is a bad one.

Of the two germicides, Bordeaux mixture is both the better and the easier to apply. Tar* is less efficacious, and when used in conjunction with Bordeaux mixture it does not appreciably improve the results.

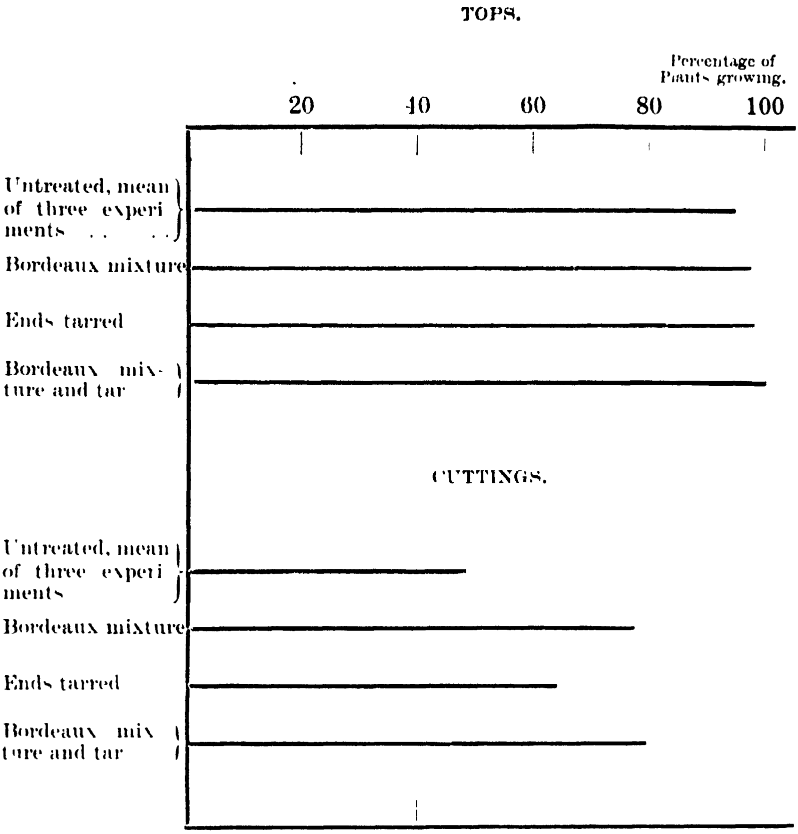
In our experiments we obtained the following results, the numbers being the percentage growing:

	1902-3.		1903-4.	
	Tops.	Cuttings.	Tops.	Cuttings.
Untreated	60	18	95	48·2
Bordeaux mixture ..	96	75	98	78
Ends tarred	63	27	99	63
Bordeaux mixture and tar	90	57	100	79·5

The season 1903-4 was much more propitious for planting than that of 1902-3.

* The ends of the canes planted were tarred.

The results for 1903-4 are shown in diagrammatic form as follows: —



The use of Bordeaux mixture is cordially commended to planters: it is cheap, simple, and efficacious and may prove decidedly useful when endeavouring to plant canes in districts liable to fungoid diseases. It is not necessary, as at first suggested, that the tops or cuttings should be soaked for *two* hours.

Bordeaux mixture is best prepared by the following formula: —

Copper sulphate (blue stone)	6 lb.
Unslacked lime	4 lb.
Water	50 gallons.

The 6 lb. of copper sulphate (blue stone) are dissolved in 25 gallons of water in a *wooden* tub or barrel. It is best to tie the crystals of blue stone in a piece of sacking and suspend it in the water from a stick laid across the top of the barrel. At the same time 4 lb. of *freshly-burnt* unslacked lime are slowly slacked, and the resulting paste made up to 25 gallons with water and well stirred. Next, the lime wash and solution of

blue stone are slowly poured together into a third tub or barrel holding from 50 to 60 gallons. When the mixing is complete, the blue liquid is stirred for a minute and tested by placing therein a clean, bright knife-blade for one minute. If the knife-blade remains bright, the Bordeaux mixture is safe; but if it becomes covered with a deposit of copper, more lime milk must be added until this deposit ceases to form. Prepared in this way the blue substance in the mixture does not settle readily nor does the mixture require much stirring before use.

Mr. J. R. BOVELL (Barbados): In Barbados, so far, two experiments have been conducted with the object of ascertaining, first, whether the treatment of cane cuttings by tarring the ends prevented fungus spores germinating and infecting them; and secondly, whether soaking them in Bordeaux mixture had the same effect.

In December 1902 experiments were conducted to answer the first question. Ten series of experiments were carried out on four estates and five on another. On each of the first four estates 100 holes were planted for each experiment, on the fifth 2,820 holes were planted.

In the first and sixth series the cuttings were planted in the usual estate way, that is. soaked in water for twelve hours and planted. leaving the top ends uncovered.

In the second and seventh series the cuttings were soaked in water for twelve hours and planted. the top ends being covered with soil to a depth of $\frac{1}{4}$ inch. This, it was hoped, would prevent fungus spores reaching the top ends and also prevent insect attack

In the third and eighth series after soaking in water for twelve hours the top ends of the cuttings were tarred. In these series the top ends were left uncovered.

In the fourth and ninth series the cuttings were treated as in the third and eighth, but on planting the cuttings were covered with $\frac{1}{4}$ inch of soil.

In the fifth and tenth series both ends of the cuttings were tarred and the top end was covered with $\frac{1}{4}$ inch of soil.

The results of these series of experiments have so far proved inconclusive; the percentage of cuttings which germinated being practically the same throughout the experiments, varying from 72 per cent. to 81 per cent. The average in the first series being 80, in the second 73, in the third 81, in the fourth 74, in the fifth 81, in the sixth 76, in the seventh 72, in the eighth 80, in the ninth 73. and in the tenth 79 per cent.

The experiments with Bordeaux mixture were carried out in six fields attached to the Government Industrial School (Dodds) between November 17 and the end of December last. In these fields, 9,900 holes were planted in the usual manner in which the seedling canes are planted, i.e., by cutting and taking them from the plots in which they are growing direct to the plots in which they are to be planted, thus avoiding any likelihood of the cuttings becoming mixed. At the same time 4,660 holes were planted with cuttings that had first been

soaked for two hours in Bordeaux mixture made according to the directions given in the *West Indian Bulletin* (Vol. II, p. 210).

During the time the cuttings were germinating the weather conditions were favourable to their growth, showers falling at short intervals. In the case of the untreated cuttings 81·6 per cent. germinated, and in the case of the cuttings soaked in Bordeaux mixture 91·8 per cent. germinated. The average difference in favour of the cuttings soaked in Bordeaux mixture was 10 per cent., the maximum in the case of the non-treated cuttings being 86 per cent., and the minimum 77 per cent. In that of the cuttings soaked in Bordeaux mixture the maximum was 97 per cent. and the minimum 89 per cent.

DISCUSSION.

The Hon. B. HOWELL JONES (British Guiana): The vast number of cane plants with which we have to deal renders it impossible to adopt the method of treatment recommended by Dr. Watts.

Mr. PETER ABEL (Trinidad): That is also the case in Trinidad.

The Hon. S. HENDERSON (Trinidad): On the estates with which I am connected, tops for planting are selected from the best canes. On one estate the plants are soaked in white-wash for about an hour before being planted. The method of planting adopted is to leave about an inch of the plant above ground. Cuttings are only used when it is impossible to obtain tops, the experience here being that cuttings germinate very slowly, and, in many cases, after germinating are apt to die.

Mr. E. M. DEFREITAS (Grenada): In Grenada the system is exactly that as described by Mr. Henderson as obtaining in Trinidad. It is found that the plant germinates more quickly if a part of it is left above ground. If entirely covered, the plant does not germinate.

The Hon. G. TOWNSEND FENWICK (Trinidad): Thirty years ago, when I was in charge of estates in Mauritius, that system was regularly pursued, and the material used for soaking was lime water; but the practical difficulty referred to by Mr. Abel of dealing with plants on a large scale led to its being dropped, and when I left Mauritius the practice had been discontinued.

Dr. FRANCIS WATTS: The general custom in the Leeward Islands is to bury the plant entirely. I might suggest that in cases where, as Mr. Henderson points out, the plant dies when entirely covered, death is due to fungoid attacks induced by moisture. If, as has been said, it is possible to treat plants with lime wash, then it is equally easy to soak them in Bordeaux mixture. If the magnitude of the operation is a barrier to adopting this method, then the magnitude of the operation will prove a barrier to cultivation. On the other hand, if without treatment of any kind the plants germinate as they did in Antigua this year, then it is a question whether the expenditure should be incurred. In

those islands which suffer from drought, and the operation of supplying the apparently dead holes is considerable, it seems to me that considerable expense is spared by ensuring a much larger spring of canes by treating them in this manner.

The PRESIDENT: In the paper read by Mr. Howard at a previous Conference the formula for Bordeaux mixture is given: 50 gallons of water to 4 lb. unslacked lime and 6 lb. copper sulphate, at a cost of 50c.; that is sufficient for 25 acres. Bordeaux mixture has been recognized as a good treatment, and in almost every publication of the Department bearing on the question the formula is given. The alleged difficulty as to the magnitude of the operation in certain colonies might be overcome by the use of a large vat. Planters have overcome greater difficulties than that. The only question is whether in good seasons it is worth while doing it.

Mr. G. S. EVELYN (Barbados): It was the custom in Barbados in years gone by to soak the plants in ordinary water for twelve hours before planting. I should like to ask Dr. Watts whether that is the practice in the Leeward Islands.

Dr. FRANCIS WATTS: That is done occasionally with the object of hastening germinaton. It depends, however, upon the season.

THE POLARIMETRIC DETERMINATION OF SUCROSE.

BY THE HON. FRANCIS WATTS, C.M.G., D.Sc. F.I.C., F.C.S., AND H. A. TEMPANY, B.Sc. A.I.C.

For several years a keen controversy has been waged concerning the influence of temperature upon the polarimetric determination of sucrose. Alteration of temperature affects the determination in several ways: by causing changes in the volumes of the measuring vessels and polarimeter tubes, by altering the optical activity of the quartz which forms an essential part of some forms of polarimeter, and possibly by affecting the optical activity of sucrose itself.

Concerning all these points, except the last, there is absolute agreement between all the workers in this field; the last has, however, given rise to very warm discussion. This has been reviewed by Dr. Wiechman in a paper presented to the International Commission for Uniform Methods of Sugar Analysis*

*Reprinted in the *International Sugar Journal*, Vol. II (1900), p. 101 et seq.

in which he reviews the work of different observers, whom he classifies in two lists, namely, (*a*) those who maintain that change of temperature has no perceptible effect on the optical activity of sucrose, and (*b*) those who maintain that the effect is perceptible, and measurable, and of sufficient magnitude to be taken into account in laboratories working at tropical temperatures.

The question is of considerable commercial importance owing to the fact that large quantities of sugar are produced and sold in countries having a tropical climate and are then transferred to, and refined in, countries possessing a temperate climate. Should temperature affect the optical activity of sucrose to such an extent as to alter it even by ·3 per cent. for a range of some 12° C., as some observers claim, then the seller in the tropics may be claiming payment on a basis which is in error by ·3 per cent. This may appear small in itself, but when applied to some 4,000,000 or 5,000,000 tons of cane sugar produced in the tropics it means a sum in dispute of £120,000 to £150,000 a year.

The subject has assumed great importance from the fact that the United States Government has decided that in determining the polariscopic test of sugar for customs purposes, the alleged change in the optical activity of sucrose with change of temperature shall be taken into account and a corresponding correction made, thus giving important official sanction to the views of one party. This has the effect of increasing the revenue by some $100,000 or more a year over the amount that would be levied, were the polariscopic test made in the tropical countries in which the sugar is grown, a sum sufficiently large to attract the attention both of revenue authorities and those dealing in sugar.

In view of the statements contained in the interesting paper by Wiechman, already referred to, we set ourselves to inquire into the question with a good deal of care. Pure sugar from Khalbaum was used in the work, this was carefully dried before use.

As a result we found that the standard weight of 26·048 grammes of sucrose dissolved in 100 *true* cubic centimetres of distilled water at 30° C. and read at a temperature of 29·3° C. gave a reading of 99·765, and in a second case when observed at 29·7° C. a reading of 99·79 on the Ventzke scale.* Introducing a correction of ·034 per degree C. for the slight contraction due to change of temperature during the polarimetric observations, these readings become 99·745 and 99·78 respectively. The readings are the means of a series taken by two observers: they are in close agreement and are within the limit of accuracy obtainable on our instrument (a triple-field Schmidt and Haensch 'white light' polarimeter). This instrument was checked by means of quartz plates which had been carefully standardized, both at the Reichanstalt Charlottenburg, and by Dr. H. W. Wiley at Washington.

These readings, however, are not true percentages of sucrose in the sample of cane sugar. The following points require to be taken into consideration:—

(a) The Ventzke scale is based upon the solution of 26·048 grammes of sugar in 100 Mohr cubic centimetres equal to 100·228 true cubic centimetres. Hence our readings must be corrected by multiplying by $\frac{100}{100.228}$, as our solution was too concentrated for proper observation on the Ventzke scale.*

(b) It is well known that the optical activity of quartz itself and therefore of the quartz wedge of the Schmidt and Haensch polarimeter is affected by temperature : this has been carefully studied by Jobin (*Zeitschrift des Vereins fur Ruben Zucker Industrie*, 1898, p. 835) who finds that the correction to be applied to Schmidt and Haensch instruments may be expressed by the formula, Polarization + (·00016t) N, where t is the difference of temperature of observation from that at which the instrument was standardized, and N is the scale reading.

In the case of our observations this correction is

(a) $\cdot 00016 \times 11{\cdot}8 \times 99{\cdot}745$ or ·188 degrees Ventzke.

(b) $\cdot 00016 \times 12{\cdot}2 \times 99{\cdot}78$ or ·195 „ „

Our readings in the two series of experiments thus become

$$99{\cdot}745 + {\cdot}188 = 99{\cdot}933$$

$$\text{and } 99{\cdot}78 + {\cdot}195 = 99{\cdot}975$$

And when corrected for the relationship between Mohr and true cubic centimetres,

$$\frac{99{\cdot}933 \times 100}{100{\cdot}228} = 99{\cdot}705 \text{ and } \frac{99{\cdot}975 \times 100}{100{\cdot}228} - 99{\cdot}748$$

In the first instance we therefore observe a difference of ·294 per cent., and in the second one of ·252 per cent. We believe that we are correct in attributing this difference to the effect of temperature upon the optical activity of sucrose. These results are in as close agreement with those of Wiley and Harrison as can be expected when the observations are made with a polarimeter.

From the above observations we conclude that changes of temperature (up to about 30 C.) cause a lowering of the reading on the Ventzke scale which may be corrected by the formula Polarization + (·00023t) N, where t is the difference of temperature of observation from that at which the instrument was standardized, and N is the scale reading observed.

For solutions requiring no clarifying reagents we recommend the following :—

The solution of 26 grammes of sugar in 100 *true* cubic centimetres. (This is equivalent to 26·048 in 100 Mohr cubic centimetres.)

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*Note. The true cubic centimetre is taken as being the volume of one gramme of water weighed in vacuo at 4° C., while 100 c.c. Mohr are defined in this case as being 100 grammes of water at 17·5° C. in air, no correction being made for the effect of the displacement of air ; under these conditions 100 c.c. Mohr become equal to 100·228 c.c. true ; see Wiley, *Principles and Practice of Agricultural Analysis*, Vol. III., p. 99.

The correction quartz change by Jobin's formula, and the correction 'Sucrose change' by the above formula, Polarization +(·00023t) N, or combining the two, Polarization + (·00039t) N.

ERROR DUE TO THE VOLUME OF THE LEAD PRECIPITATE.

The foregoing method will give correct determinations when working with solutions requiring no clarification, but a serious error is introduced when the ordinary method of clarification is used—consisting in adding a solution of basic acetate of lead to the sugar solution and subsequently making up to 100 c.c.—due to the volume occupied by the lead precipitate, which results in the sugar being dissolved in less than 100 c.c. of solvent.

The question of the effect of the volume occupied by the lead precipitate has been treated by several writers, but does not appear to have received the general attention it demands. This lack of attention is probably due to the difficulty experienced in measuring it, and as it varies with each class of sugar dealt with, observers have found great difficulty in satisfying themselves of the appropriate correction to apply.

The method usually suggested for measuring this volume is that of Scheibler. In this method the sugar is dissolved in water, a measured quantity of solution of basic acetate of lead is added, the volume made up to 100 c.c., the solution filtered and the polarimetric determination made in the usual way. A second solution is made in a precisely similar manner except that the volume is made up to 200 c.c.: this is filtered and a polarimetric reading taken. The true polarimetric reading of the sugar under examination is obtained by doubling the second reading and deducting this quantity from the first reading, the difference is multiplied by two and deducted from the first reading, the result is the corrected reading. From this the volume of the precipitate can be readily calculated. This has been discussed by Weichman in a paper read before the International Congress of Applied Chemistry at Berlin, June 1903,* in which he points out several objections to it and suggests other methods.

The chief objection to our minds lies in the fact that the possible errors in reading the polarimeter are of greater magnitude than the quantity it is sought to measure, as the following will show:—

The volume of the lead precipitate, in the case of muscovados, can be taken as affecting the polarimeter readings to the extent of some ·2 to ·4 Ventzke scale divisions, while the accuracy with which a reading can be taken is about ·05 to ·1 Ventzke scale divisions.

If we take a case in which the respective readings in a double dilution experiment were 90·7 and 45·3 respectively, the corrected reading would be 90·5; if, however, the original readings are assumed to be in error to the extent of ·05 divisions of the scale, and we calculate the corrected readings for all possi-

* *International Sugar Journal*, Vol. V, 1903, p. 376.

ble values, we obtain 'corrected' readings ranging from 90·25 to 90·7, a variation greater than the quantity to be measured. This method is therefore obviously inapplicable.

A second is that of Sachs. This is described by Wiechman as follows: 'A precipitate is produced by subacetate of lead. This precipitate is washed with cold water and with hot water till all the sugar is removed, and is then introduced into a 100 c.c. flask: a normal weight of pure sugar is added, and the solution is made up to 100 c.c. with distilled water. This solution is well mixed, filtered and polarized, and the volume of the precipitate ascertained in the following manner:—

A = Percentage of purity of the sucrose in solution.

B = Polarization of the solution when containing the precipitate.

V = Volume of the precipitate is equal to $\frac{100B - 100A}{B}$

This method is unsatisfactory partly from the want of delicacy of the optical method where errors of ·05 to ·1 degree Ventzke may occur in each reading, and partly because it involves much handling of the precipitate.

All optical methods are open to the objection that the experimental errors are bound to be relatively large, and the results on small volumes of precipitates relatively inaccurate.

Other methods therefore should be sought to effect this measurement. A densimetric method at once appears rational and obvious. Unfortunately, a method based on double dilution is not directly applicable to this problem, for the 'excess gravity' of sucrose solutions is not a direct function of the concentration as shown by the classic researches of Gerlach and others, and any attempt to measure the volume of the precipitate by the effect of dilution on the specific gravity becomes extremely complicated. We have spent much time in an attempt to apply this principle to the problem but without success.

Wiechman* adopted a process based upon cautious precipitation with subacetate of lead, filtering off the precipitate and washing it with hot and cold water, after which it was dried at 100 C. and weighed. The specific gravity of the precipitate was ascertained by weighing in Benzene. Wiechman's method involves some inconveniences particularly in that it requires a good deal of manipulation of the precipitate. We have adopted a modification which reduces the work, and is, we believe, more satisfactory.

In our method the operations of preparing the solution, precipitating with lead acetate† and making up to 100 c.c. are performed in a tared specific gravity flask, the water content of which is accurately known. The flask with its contents is weighed, after which the solution is filtered off and its specific gravity accurately taken. The precipitate is washed with water till free from sugar, dried at 100° C and weighed, a

*Loc cit.

† 2 c.c. of a solution of basic lead acetate of Sp. Gr. 1·27.

tared filter paper being used to reduce the manipulation required. From these data the volume of liquid displaced by the lead precipitate is readily calculated.*

By using the solution from which the precipitate is thrown down as the medium in which its specific gravity is taken, we avoid a good deal of manipulation and at the same time we have a medium in which it is quite insoluble. The subsequent operations of washing, drying, and weighing give but little trouble.

Following this method the precipitates produced in the clarification of several sugars, have been examined with the following results:—

No.[1]	Weight of precipitate from normal weight of sugar.	Volume of precipitate.	Sp. Gr. of precipitate.
1	·6506 gms.	·35 c.c.	1·859
2	·6530 „	·33 „	1·945
3	·6609 „	·35 „	1·888
4	·7240 „	·39 „	1·856
5	·7389 „	·44 „	1·680
6	·7400 „	·42 „	1·760
7	·6786 „	·305 „	2 229
8	·6731 „	·45 „	1·495
9	·656 „	·42 „	1·560
10	·416 „	·25 „	1·640

[1] Nos. 1-8 are Muscovado Sugar. No. 9, Low grade Crystals. No 10, Yellow Crystals.

From these results, as well as from those of other observers, it is obvious that a very considerable error is introduced into the polarimetric determination of sucrose, if no account is taken of the volume occupied by the lead precipitate.

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* Weight of solution and precipitate contained in tared Sp. Gr. flask—109 738 gms. (A).

Sp. Gr. of solution $\frac{30\ C.}{30°\ C.}$ — 1·0976 (S).

Water content of flask at 30° C. = 99·723.

Whence solution content of flask at 30° C. = 109,446 gms. (C).

Weight of precipitate = ·7240 gms. (B).

C (A − B) − ·432 gms. = W.

$V = \frac{W}{S} = $ ·39 c.c. with sufficient approximation,

When working at tropical temperatures in the neighbourhood of 30° C., the error produced by the volume of the lead precipitate to a large extent compensates the errors introduced by the effect of temperature on optical activity of sucrose and on the quartz wedge of the Schmidt and Haensch polarimeter. Thus tropical observations in which no corrections are introduced are more in accord with theoretically accurate readings than those in which corrections are made for the effect of temperature on the optical activity of quartz and sucrose while neglecting the effect of the volume occupied by the lead precipitate.

In laboratories having a temperature near to that at which the polarimeters are standardized, and where no temperature corrections are necessary, the error introduced by the volume of the precipitate is serious.

A method of clarification has been proposed by A. D. Horne* by which, it is claimed, the error due to the volume of the lead precipitate is eliminated or reduced to a negligible quantity, while the method itself is as simple as those in ordinary use, and entails no extra work on the observer.

Horne's method consists in making up the sugar solution to the required 100 c.c. before adding the precipitating reagent, and using dry anhydrous basic lead acetate as the precipitant and clarifying reagent. This ensures that the sucrose is dissolved in 100 c.c. of solution and presumes that no change is introduced into the volume of the solution during the process of clarification. This appears to be the case provided that excess of the lead salt be avoided. The volume of the radicle entering into solution appears to compensate very closely the volume of the complex radicles removed by precipitation. To ensure accurate results, therefore, it is necessary to avoid the use of an excess of lead salt, for if excess be used the volume of the solvent liquid is increased and error creeps in.

We have examined this method critically in the case of several samples of sugar, by determining the polarization when the solutions were clarified with basic lead acetate before making up to volume, then determining the volume of the lead precipitate in the manner already mentioned and correcting the polariscopic reading of the volume of the precipitate. The same samples were then clarified using Horne's method † and the results were compared.

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* Read before the New York section of the American Chemical Society, December 1903.

† The weight of dry basic lead acetate used by us in our experiments was ·35 gms.

Proceeding in this way we obtain the following results:—

No.[1]	Vol. of Ppt.	Polarization usual method.	Polarization corrected for vol. of ppt.	Polarization Horne's method.	Difference.
1	·33 c c.	89·55	89·26	89·35	·09
2	·35 „	86·50	86·20	86·20	·00
3	·39 „	87·55	87·23	87·25	·02
4	·44 „	90·30	89 91	90·00	·09
5	·42 „	87·65	87·29	87·30	·01
6	·30 „	86·70	86·44	86·45	·01
7	·42 „	90·00	89·58	...	...
8	·25 „	97·40	97·15	97·20	·05

[1] Nos. 1-6, Muscovado Sugar. No. 7, Low grade Crystals. No. 8, Yellow Crystals

In order to ensure accuracy and to avoid errors in sampling low-grade sugars, in each case a considerable quantity of the sugar under examination was dissolved in water and the required quantities of this solution weighed out, instead of weighing the sugar directly, greater uniformity being attainable by this method.

From these results we may conclude that Horne's method is a distinct advance in the direction of accuracy, whilst its simplicity will commend it to all workers.

As the outcome of this investigation we reccommend the following method of working as generally applicable:—

(1) Use a weight of 26 grammes of the sample of sugar, dissolve in distilled water and make up to 100 true cubic centimetres.

(2) Clarify by means of anhydrous basic lead acetate, avoiding excess.

(3) Polarize at the temperature at which the solution is prepared and correct for temperature by the formula, Polarization + *(·00038 t) N, where t is

* If the temperature is below that of standardization, the correction will be - instead of +.

the difference between the temperature of observation and that at which the instrument was standardized, and N is the Ventzke scale reading.

Working in this manner will, we believe, secure a high degree of accuracy and at the same time uniformity between those working under diverse climatic conditions. We therefore commend this method to the careful consideration of those responsible for securing uniform methods of sugar analysis, whether for official or technical purposes.

THE CENTRAL SUGAR FACTORY IN ANTIGUA.

BY THE HON. FRANCIS WATTS, C.M.G., D.Sc., F.I.C., F.C.S.,

Government Analytical and Agricultural Chemist for the Leeward Islands.

At the West Indian Agricultural Conference in 1900 Mr. F. J. Clarke reviewed the efforts which had been made to establish Central Sugar Factories in Barbados, while it fell to my lot to review those which had been made in Antigua. After describing effort after effort we were compelled in every instance to conclude with the comment 'nothing further seems to have been done.'

The period since 1900 has not been an inactive one in Antigua. In 1901 an effort was made which bade fair to come to fruition. Sir Henry M. Jackson, who was then the newly appointed Governor of the Leeward Islands, gave the proposals his warmest support, but unfortunately they broke down.

Early in 1903 Sir Gerald Strickland ascertained that a residual sum, arising out of a Parliamentary Grant of £250,000 to assist the West Indian sugar industry pending the confirmation of the Brussels Convention, was available for application within his Government if satisfactory proposals could be put forward. He adopted the bold course of suggesting that a sum of £15,000 should be offered as a bonus, under certain restrictions, to the group or company which would put forward and carry into execution the best Central Factory scheme for Antigua. The conditions were laid down with some stringency so as to ensure that the money, if granted, would be faithfully applied, and I was sent to England to confer with the Colonial Office in the hope of seeing the negotiations successfully put through.

It may be well to point out that the £15,000 constituted no new grant, but was merely a question of distribution and allotment of the original Parliamentary Grant made some long time before.

It is unnecessary to go through the various negotiations; suffice it to say that after much hard work and some anxious moments, when it was feared that our work might be lost,

a company was found prepared to fulfil the requirements of the Government and to make what, I believe and hope, will prove a very good bargain for itself and the sugar planters of Antigua.

Briefly stated, the position is this: The Factory Company and the estates' proprietors have agreed to co-operate, the former to build and work the factory, the latter to grow and supply the canes, during a period of fifteen years, on a profit-sharing basis. This co-operation, to my mind, constitutes the strongest point in the venture, as it is calculated to secure the interest and goodwill of all concerned.

Divested of technicalities the situation may be thus described :—

The capital of the Factory Company is £40,000, including the £15,000 contributed by the Government. It is anticipated that, with rigid economy, this sum will be found sufficient.

The company agree to erect a well-equiped factory capable of making 30 tons of 96° crystals in a day of twenty-three hours; this factory to be equipped and constructed in a manner satisfactory to the Government.

To provide reasonable railway facilities for the transport of canes.

To pay for canes the equivalent price of 4½ tons of 96° crystals, f.o.b. Antigua, for each 100 tons of canes. This may be regarded as a payment 'on account.' After the payment of working expenses, interest on capital and setting aside of a reasonable amount to sinking and reserve fund, any profits which arise are to be dealt with in the following manner: Should the price paid for canes prove less than 10*s.* per ton, then the profits shall be applied to bringing up the payment to 10*s.*, or as far in that direction as the amount available permits. If after canes have been paid for at 10*s.* per ton, or over, any profits still remain unallotted, these profits are to be divided equally between the shareholders of the company and the estates' proprietors supplying canes.

Of the £15,000 contributed by the Government £1,000 is amortized each year, so that at the end of fifteen years this will disappear from the company's capital account. As soon as the £25,000 subscribed by the company shall have been paid off, the ownership of the factory will be divided equally between the shareholders in the company and the estates' proprietors supplying canes.

The estates' proprietors bind themselves to maintain a certain acreage in cultivation with sugar-canes, and to supply the canes so grown to the factory for a period of fifteen years.

This is the essence of the contract; there are necessary minor points, dealing with the quality of cane, the methods of payment, the provision for arbitration in case of disputes, the manner of distributing the ownership of the factory when the capital is paid off, and such like, which are, I hope, calculated to give security to both parties, and to provide for all the changing circumstances of the next few years. I think this

contract, of which I have copies here, which I shall be pleased to show to, and discuss with, any one interested, is equitable and helpful to all parties to it.

In addition to this the company is under an obligation to the Government to take, if offered, canes from the peasantry up to 4,500 tons a year at a price equal to the value of 4½ tons of 96° crystals, f.o.b. Antigua, for each 100 tons of canes, but with the proviso that the price to be paid for peasants' canes shall in no case be less than 7*s*. 6*d*. per ton ; good, sound canes being stipulated for. It is probable that this will stimulate many of the more industrious and thrifty peasants to cultivate their small holdings in a profitable manner, and afford an opportunity for hard-working men to improve their positions.

Eight estates have entered into co-operation with the Factory Company and have agreed to supply canes from an area of 1,620 acres in each season. It is estimated that in average seasons this area, together with the supply of peasants' canes, will yield about 3,000 tons of sugar.

The Factory Company has now erected a factory equipped with two Babcock & Wilcox water-tube boilers having 11,528 square feet of heating surface, calculated to work at a pressure of 160 lb. per square inch, but fitted with reducing valves whereby steam is delivered to the factory at a pressure of 100 lb. per square inch.

An engine having a cylinder 26 inches in diameter, with a stroke of 4 feet.

Two three-roller mills having rollers 60 x 30 with provision for maceration.

A triple-effect apparatus having a heating surface of about 4,000 square feet.

Two juice heaters, each having 1,000 square feet of heating surface.

Two vacuum pans each capable of striking 15 tons of massecuite or about 9 tons of dry sugar, and having a heating surface of 450 square feet.

A central condensing installation is fitted to serve the triple-effect and vacuum pans, consisting of a condenser on the Torricellian principle, and a dry air pump to remove air and uncondensible gases from the condenser. Arrangements are made whereby air may be gradually exhausted from any vessel when required, e.g., when a pan is started after striking.

Five Weston 36-inch, belt-driven centrifugals, three of which are intended for 1st. sugars and two for 2nds. These are provided with all the necessary pug-mills, grass-hopper sugar conveyors, and chain-and-bucket elevators for delivering sugar into the store-room.

Six second sugar crystallizers, each capable of holding a full strike from one of the vacuum pans, fitted with stirring gear.

Together with all the necessary vessels and appliances for the manufacture of 30 tons of grey crystals in a day of

twenty-three hours. These it would be tedious to enumerate at length here.

The machinery is housed in buildings constructed of rolled steel columns of H section, and covered with galvanized iron.

The mill house is provided with a travelling crane capable of lifting 12 tons.

The buildings and mill yard are lighted by electricity.

A small laboratory provides accommodation for the resident chemist.

The machinery was provided and erected by Messrs. Mirlees Watson & Co., of Glasgow. The railway was constructed by the Factory Company under a separate contract.

Six miles of railway are laid down to convey the canes from the estates to the factory. The rails are 30 lb. per yard, and are laid to a guage of 2 feet 6 inches. Two locomotives are provided for haulage.

While the construction is not yet complete in all its details, matters were so far advanced as to permit of an official 'opening' and short trial of the mills, etc., on Monday, December 19, under the ægis of his Excellency Sir Courtenay and Lady Knollys. On this occasion everything went with such smoothness and precision as to augur well for successful working.

After so many years of hard work on the part of many in Antigua interested in this movement, and after so many abortive efforts, it is satisfactory to know that at last we have in Antigua a Central Sugar Factory of modern dimensions fitted with simple but excellent and adequate machinery, connected with a cane supply by a contract fair to all parties, a contract based on a co-operative form of working which will induce everyone bound by it, whether on the factory or on the cane-supply side, to use every effort to make this pioneer factory a success.

This factory is calculated to solve many problems concerning which we have only been able to put forward solutions based on hypotheses of approximations and estimates. Should the solutions tend in the direction which I anticipate, I foresee considerable extension of the factory work and the possibility of many other factories on similar co-operative lines, not only in Antigua, but in other islands where the muscovado process of sugar manufacture still lingers: and I am sure all who are interested in the sugar problems of the smaller islands, while waiting for results, wish our pioneer factory the success which we ourselves desire for it.

NOTE ADDED: Since the above was written the factory has manufactured a considerable portion of its crop of sugar for the season 1905. Work has proceeded in a very satisfactory manner so that we are now practically assured of its successful working.

It is not possible at this early date to give a detailed account of the working or figures showing the recovery of

sugar, but there is good reason to believe that the estimation of the promoters will be fully realized.

The cost of the factory, so far as can be ascertained at this stage, has been approximately as follows :—

	£	£
Cost of plant	21,315	
Additions to plant...	633	
Houses, offices, laboratory, etc.	1,000	
Freight	3,467	
Lighterage, insurance, package tax, etc. ...	683	
Erection (not yet fully known), say	7,500	
Water tower, ponds, pipes, etc.	700	
Sundries	400	
Legal	360	
Consulting engineer	350	
	£ 36,408	36,408
Railway, 5½ miles		
line and construction	3,840	
2 Locomotives	980	
120 Waggons	1,100	
Sundries	80	
	£6,000	6,000
		£ 42,408

The estimated sum of £40,000 has thus been exceeded by £2,408. These figures at this stage can only be given as approximate and provisional. The cost of the plant is extremely low. For safe estimating for any other factory £50,000 should be allowed.

DISCUSSION.

The PRESIDENT: The erection of this factory is one of the most important events connected with the sugar industry in the Leeward Islands. Members of this Conference will be glad to learn that in obtaining the establishment of Central Factories at Antigua, Dr. Watts has himself contributed a large share—in fact it is in connexion with his efforts in this and other directions that His Majesty the King was pleased to confer on him the Companionship of the Order of St. Michael and St. George. That is evidence that our work in the West Indies is followed closely at home, and that the prosperity of these colonies lies closely to the heart of the English people.

EXPERIMENTS IN IMPROVING THE HEALTH AND PRODUCTIVENESS OF CACAO TREES.

Mr. J. H. HART (Trinidad): Our experiments have only just been initiated and have hardly reached a stage to justify saying anything about them. One or two things have, however, been brought to the notice of planters, and have, I am glad to say, been taken advantage of with considerable success. The first is the method of dealing with the pod disease. The methods suggested by me to the Trinidad Agricultural Society, and also by the Imperial Department of Agriculture, which consist in the burning, burying, and disinfecting of diseased pods, have been especially successful in dealing with the disease called *Phytopthora*, and I was agreeably surprised to be told recently that, as the result of their adoption on one of the largest estates in the island, the proprietor expected to get 25 per cent. more cacao than he otherwise would have done. Mr. deGannes has also adopted similar treatment with equal success. Another thing which we have been trying to impress upon small planters especially is the desirability of pruning cacao trees so as not to leave wounds which cause rot of the centre of the stem. Again, where wounds and holes occur we strongly recommend a system of cleaning them and filling them with a mixture made of ordinary cement and sand. This gives the trees renewed vigour and prolongs their life for many years. Tar is also recommended for use in pruning and I am glad to say the practice has been adopted on a large number of estates. Few manurial experiments have as yet been carried out, but those recommended are being adopted, and I shall be able to report on them at a later period.

Mr. J. G. DEGANNES (Trinidad): With few exceptions the cacao cultivation in this island has received, up to a year or two ago, little attention beyond the ordinary method of upkeep handed down by our forefathers, but it seems now as though the cacao planters are realizing the necessity of higher cultivation. So far, artificial manures have not been extensively made use of, but where they are being tried the results are encouraging. Basic slag is the manure most generally applied. Some very good results are obtained by the use of pen manure prepared with gypsum, and on some very old properties its use, and that of sheep manure forked in, have been remarkable in improving the health and productiveness of the cacao trees. The island has had up to now, thank God, few cacao diseases to contend with, the 'Brown Rot' and 'Canker' being the only two. The measures successfully adopted to combat them, have been the treatment suggested, I believe, by the Imperial Department of Agriculture, and, with the advice and assistance of Mr. Hart, the Superintendent of the Botanic Gardens here, they are kept under control. The cacao trees of the plantations situate in the valleys suffer considerably from 'moss' on account, I presume, of the excessive moisture, and it would be desirable if some other and more efficacious means than the brush or the hand—the 'knapsack' sprayer having totally failed for the

purpose—should be found to deal with it. There are several patent cacao dryers of different patterns used for the curing of the cacao bean and I am informed that they give satisfaction, but personally I shall adhere to the opinion that the sun-dried article is preferable. With regard to green dressing I am not aware that it is resorted to to any great extent. I gave it a tria on one of my properties in October last, and so far I have not noticed a very marked change in the look of the trees. In conclusion, I regret that, owing to the short time since experiments have been started in the colony, I have no statistics to offer. '

The PRESIDENT: With the object of assisting the cacao industry in Grenada, St. Lucia, and Dominica, we undertook a series of what we called sample plots of cacao: that is to say, we took over plots of land, about 1 acre in extent, near the public road from proprietors who were willing to allow us the use of the land, and to assist in the cultivation. These plots were labelled 'Imperial Department Plots.' In most cases they consisted of cacao which was not in good health. The Department paid the expense of cultivation, the Agricultural Instructor visited these plots, which became central points for giving information to cultivators in the district. The planter who gave the use of the plot became the agent of the Department in his district, so that when the Agricultural Instructor visited the plot he would see the planter and discuss with him the best way of utilizing his time while in the district. Sometimes it was suggested that a meeting would be held at which the cacao growers in the district should be present. After the Instructor had been introduced to them by a person they knew, they were ultimately willing to receive and hear the Instructor and follow his advice. Some people might regard the establishment of sample plots as giving assistance to the large proprietors by taking a portion of their land and cultivating it for them. However, we are quite satisfied with the results, as the feeling that has been created among small proprietors by our taking an interest in their cultivations has more than repaid us for the trouble and expense which the establishment of these plots has occasioned. As the result of sample plots in Grenada, a paper in connexion with one of these has been circulated among members of the Conference. Peasant proprietors who had scouted the idea are now making drains and pruning their trees, applying manures and fully carrying out the recommendations of the Department. I believe these sample plots have been very beneficial. We have gone through our first series and shall now begin another. The plots in Dominica I hope to place under the supervision of Dr. Watts, so that can he make experiments with chemical manures and carry on the work more closely on scientific lines. Mr. Hudson has had charge of the plots in St. Lucia and he will be able to tell you himself what is being done there.

CACAO MANURIAL EXPERIMENTS AT GRENADA.

The following report and table, showing the results of the working of the cacao experiment plot at Nianganfoix estate,

Grenada, were forwarded by the proprietor for publication (see *Agricultural News*, Vol. III, p. 347):—

This plot was handed over on September 30, 1903, by the Department of Agriculture to the proprietor who still carries on the experiments, in order to obtain the highest possible yield from an acre of land by the use of fertilizers and green soiling.* The plot measures 1 acre and was divided into four sections of ¼ acre each.

During the period, extending over four crops from April 1, 1900, to September 30, 1904, two applications of manures were made, as shown in the table, the first during the first crop 1900-1, and the second application in the spring and summer of 1902 just before the third crop.

A., the pen manure section, is the wettest section of the plot, and it will be noticed that, notwithstanding the heavy application of manure in May 1902, the yield fell below the two preceding crops, and only recovered after several rods of new drains had been added to those already existing—and dug diagonally across the slope. This illustrates the value of drains in a wet clay soil, without which manure is at a discount.

The potash section D. has steadily advanced and, unlike sections B. and C., which unaccountably fell off by ⅛ to ¼ bag, held its own during the crop 1902-3. The cost of production for the first two years averaged £1 per bag of cacao, and for the second two years 12*s*. per bag, or an all-round average of 16*s*. per bag for four years' working.

When the results of the fifth year's working are known, the cost of production will be considerably reduced.

The following figures show the gradual improvement in yield:—

Crop 1900-1 = 5¼ bags per acre
Crop 1901-2 = 7 „ „
Crop 1902-3 = 7 „ „
Crop 1903-4 = 8 „ „

Full particulars are given in the following table as to the details of the treatment accorded to the various sections:—

* The sections have been bedded twice yearly.

Section.	Manures applied (with dates).	Crop 1900-1.		Crop 1901-2.		Crop 1902-3.		Crop 1903-4.	
		Dry Cacao per sectional acre (pounds).	Bags per acre.	Dry Cacao per sectional acre (pounds).	Bags per acre.	Dry Cacao per sectional acre (pounds).	Bags per acre.	Dry Cacao per sectional acre (pounds).	Bags per acre.
A. $\frac{1}{4}$ acre.	June 1900.— Pen manure, 3 baskets per tree, 15 tons per acre. May 1902.— ditto. [Extra drains dug, August 1902.]	1,036	$5\frac{5}{8}$	868	$4\frac{2}{3}$	808	$4\frac{1}{2}$	1,184	$6\frac{1}{3}$
B. $\frac{1}{4}$ acre.	August 1900.— Basic slag, 8 cwt. per acre. February 1901.— Sulphate of ammonia, $1\frac{1}{2}$ cwt. per acre. May 1902.— Basic slag, 8 cwt. per acre. August 1902.— Sulphate of ammonia, $1\frac{1}{2}$ cwt. per acre.	1,112	6	1,572	$8\frac{1}{2}$	1,512	$8\frac{1}{4}$	1,648	9

Section.	Manures applied (with dates).	Crop 1900-1.		Crop 1901-2.		Crop 1902-3.		Crop 1903-4.	
		Dry Cacao per sectional acre (pounds).	Bags per acre.	Dry Cacao per sectional acre (pounds).	Bags per acre.	Dry Cacao per sectional acre (pounds).	Bags per acre.	Dry Cacao per sectional acre (pounds.)	Bags per acre.
C. $\frac{1}{4}$ acre.	August 1900.— Basic slag, 8 cwt. per acre. February 1901.— Nitrate of soda, $1\frac{1}{2}$ cwt. per acre. May 1902.— Basic slag, 8 cwt. per acre. August 1902. Nitrate of soda, $1\frac{1}{2}$ cwt. per acre.	888	$4\frac{3}{4}$	1,324	$7\frac{1}{8}$	1,309	7	1,492	8
D. $\frac{1}{4}$ acre.	August 1900. Basic slag, 8 cwt. per acre, and sulphate of potash, 1 cwt. per acre. (mixed). May 1092.— ditto.	860	$4\frac{2}{3}$	1,472	8	1,488	8	1,612	$8\frac{3}{4}$

Mr. J. H. HART: We have established in Trinidad one experiment plot on the same lines as the Grenada plots. It is at Brasso and in charge of Mr. Carl de Verteuil. It was only started a few months ago, and the results will not be available for some time.

Mr. G. S. HUDSON (St. Lucia): Experiments in improving the health and productiveness of cacao trees have been carried on in St. Lucia under the Imperial Department of Agriculture now for five years. Our method, as Sir Daniel Morris has said, has been that of taking up the most unhealthy portions of cacao we can find adjoining the main-roads, so as to bring our work as much as possible before passers by. The results have been exceedingly satisfactory. In many cases the trees had actually stopped bearing; in others, the yield was only 50 lb. of dry cacao per acre when the plots were taken over. In three years the yield had been increased to 7 bags. The policy is, as soon as we attain that standard of improvement, to hand the plot over to the owner and take a new plot in the same or another district. In our five years' experience we find we get the best results from the following method: forking throughout the plantation in January; then applying broadcast 8 cwt. of basic slag between January and April; that is followed by draining where necessary, and then thorough pruning. We find pruning to be of very great importance as it admits sunlight. After this, thorough cleanliness throughout the year. Three to four weedings are usually sufficient, but sometimes as many as six have been found necessary. In August or September we apply sulphate of ammonia, to each tree. I observe from the results of the experiments in Grenada that the best results there have been obtained from an application of sulphate of potash. In 1902 we applied nothing but potash to a 6- or 7-acre plot, and the results were negative in every case. I may mention, however, that, in combination with basic slag, the experiment has proved very valuable: but the best results were obtained from a combination of slag and nitrogen. We have also tried superphosphate but have not found it advantageous. We have obtained good results from ground bone, but that is rather expensive. Pen manure is undoubtedly the best system of manuring, but the difficulties of transportation prevent its general use. Chemical manures yielded as good results and at less cost. The only fear in the application of chemical manures is that too much nitrogen may be applied to certain soils, but in light soils there is nothing to fear Many planters seemed to fear forking, on the ground that it injured the trees, but I have never seen any bad results from careful forking. On the contrary, the results have been excellent. As the result of the experiment plots, planters in St. Lucia are now importing basic slag and sulphate of ammonia—a thing unheard of before—and pruning and forking have now become a recognized part of cacao cultivation. As a rule, we do not find it necessary to use tar or cement except in cases where a fungus disease is affecting the trees.

Dr. H. A. A. NICHOLLS (Dominica): Until the last quarter of a century the exports of cacao from Dominica were very small, as it was produced only by peasant proprietors.

When, however, the crisis overtook the sugar industry, many of the sugar planters, feeling the effects of the hard times, planted up portions of their estates in cacao and limes, and so from that time the exports of cacao began to increase. The Treasurer of the island has very kindly furnished me with certain returns which include the exports of cacao for the last ten years, which are as follows:—

EXPORTS OF CACAO FROM DOMINICA.

Year.	Export.	Year.	Export.
1894-5	851,334 lb.	1899-1900	968,740 lb.
1895-6	499,113 ,,	1900-1	992,586 ,,
1896-7	946,393 ,,	1901-2	1,052,693 ,,
1897-8	885,024 ,,	1902-3	1,309,577 ,,
1898-9	1,082,851 ,,	1903-4	1,285,245 ,, *

* Gale in August and partial failure of crops.

From this return I observe that in 1895-6 there were half a million pounds of cacao exported; but when we come to 1902-3 it is found that the exports had increased to one and a third million pounds. Last year, that is, 1903 4, there was a decrease owing to the hurricane, which, although not directly striking Dominica, seriously affected the crop. But notwithstanding this the exports of cacao reached one and a quarter million pounds. During the last few years a good deal of attention has been directed to Dominica: a new road, opening up the rich land of the interior, has been made with money granted by the Imperial Parliament and it has appropriately been called the Imperial Road. We have young Englishmen with moderate capital constantly coming out, and some of them have gone into the interior, cut down forest, and created estates, and in many instances they have planted cacao. It must, however, be borne in mind that the increase in exports to which I have referred is not due to the new planters, but entirely to the older planters, who, seeing that sugar had failed, set their energies to work in another direction: therefore, it is the industry and enterprise of the older planters—the men who have borne the heat and burden of the hard times—that have brought about the dawning prosperity of Dominica. When, however, the new settlers' estates begin to bear, then it will be found that Dominica will make a sudden leap forward along the path of progress. Coming to the cacao tree itself, I should like to make a few observations in regard to the facts brought before us by former speakers. Taking the case of pruning, I would thoroughly commend the remarks made by Mr. Hart, just as I would deprecate those made by Mr. Hudson.

If you wish a cacao tree to do well and to bear well you must perform the operation of pruning with great care. I think the Mycologist of the Department will tell you that if you cut off the branches and limbs of trees and do not tar the wound, you will probably get fungus diseases in the wood; the Entomologist of the Department will also tell you that there could not be a better site for the entry of boring beetles and such like insect pests than the unprotected wounds left by bad pruning. The more intelligent planters in Dominica use tar, and also fill up with clay any holes, or deep depressions that may be found in the tree whereby water might collect or insects get shelter. As regards manure, in days gone by the greater part of the exports of Dominica came from the peasant proprietors who had not the advantage of having brought before them, as is the case now, the scientific and technical knowledge of the Imperial Department of Agriculture; they allowed their trees to grow as they might, and did not manure them, with the result that the trees have deteriorated very considerably. The manure that is found most useful in regard to cacao cultivation is exactly the same that is found most useful in cane, and indeed in almost any, cultivation, that is farmyard manure. There can be no better manure, not only from its chemical constituents, but also its mechanical effect: it improves the soil, whilst it provides food for the trees. But where you have estates far in the interior or on steep hillsides, and with few animals, it is almost impossible to obtain sufficient farmyard manure, and in such instances it is necessary that artificial manure should be used. Hence the Dominica estates use basic slag, which contains phosphate and some free lime, and nitrogenous manures in the form of nitrate of soda or sulphate of ammonia. But in regard to nitrogenous manures it must be remembered that in Dominica, St. Lucia, and other such islands an immense quantity can be got in the forest lands by using dead leaves, lopped shrubs, and grass as a mulch for trees, and afterwards by forking this decayed vegetation into the soil. There is also a loss of nitrogen attendant on the cultivation of land in the tropics, and it must be restored by the use of farmyard manure, by green dressing, or in some other way. Mr. Hudson recommends keeping a cacao plantation thoroughly clear of weeds. That is opening up the question brought before the last Conference by Dr. Watts, who advised that in cacao and similar cultivations the land should not be kept entirely free of weeds, but that the weeds should be allowed to grow for a time and then cut down; so that the cultivation would practically get a green dressing. That is the system that has been universally adopted in Dominica for many years, and it would appear to me to be the one best suited to local conditions. There is a matter which I omitted to allude to and which may be regarded as one of the main causes of the small crops now got from peasant holdings. In removing the pod from a cacao tree it is necessary that a portion of the stem attached should be left on the tree, but the ignorant peasant, instead of cutting the pods, wrings it off, with the result that the little bud at the end of the stem which will supply the future pod is torn off, so that in time the bearing portions

of the stem are materially reduced in number. This is a matter to which Agricultural Instructors in Dominica and other islands should call the attention of peasant proprietors.

The Rev. Dr. MORTON (Trinidad): I go about among many peasant proprietors in Trinidad, and I know that the teaching of the botanist, the chemist, and the analyst has had a great effect upon them in the matter of cultivating their land. One matter referred to by Dr. Nicholls is of great importance to them, and that is the application of manures. They should be urged to use the natural manures which they can get without laying out money. Sometimes they have no money. The names of artificial manures are all new to them, but they know pen manure; and some of them from Barbados know the value of it, and the distinction made between pen manure that has been kept covered or been trampled, and pen manure that has been exposed to the sun or washed out by rain. We see in our villages to-day, as the result of cane farming, the peasant proprietor's cart going out every morning half-loaded with manure, to be returned to the soil. Not only is that the case with the ordinary manure made in the village, but the peasant proprietor has also taken to the use of liquid manure. At the Government Stock Farm where the stalls are concreted, the liquid manure which collects in little wells is daily removed by peasant proprietors. This practice is also carried out in St. Joseph and has resulted in an improved sanitary condition. What Dr. Nicholls has said in reference to weeds and shrub is perfectly true. In some cases, such as rice cultivation, the only manure which goes into the soil is the grass and weeds which grow for six months during the dry season. The practice is also valuable in connexion with cacao estates.

Mr. J. G. DEGANNES: I should not like Dr. Nicholls to run away with the idea that we do not prune our cacao trees. The only thing in which we are backward is the application of manure.

Dr. H. A. A. NICHOLLS: The remarks which I made had no reference to Trinidad but to the cultivation in the Leeward Islands.

The Hon. WM. FAWCETT (Jamaica): I have listened with a great deal of interest to the discussion that has taken place on the cultivation of cacao. The cacao industry in Jamaica is of considerable importance, although rather overshadowed by the banana industry. There we do not look upon it as you do in Trinidad and Grenada, as one of your great industries; it is rather a subsidiary industry in Jamaica: but I hope it will become in time one of our great industries. The reason why it has not advanced quicker is that the banana has been so very important. But now the planters, seeing the bad effects of hurricanes, are gradually beginning to plant their banana estates with cacao, and some have turned their banana estates altogether into cacao estates. So we wish to get hints as to the cultivation, pruning, curing, and especially shade. We owe a great deal to Mr. Hart for having written such an excellent handbook on cacao: we in Jamaica consider it a very practical and important book.

With reference to Criollo cacao and Forastero cacao, we have been much exercised in Jamaica for some time as to which is better to plant. Some planters do not think Criollo a robust plant, asserting that it is subject to disease and pests at all times. I should like to get some information from planters in Trinidad on that point. In Venezuela, where they have large estates of Criollo, some trees have died out, and attempts have been made to supply their places with Criollo, but without success, although Forastero will grow. The estates are therefore deteriorating. I should like to know whether this has been found to be the case also in Trinidad. Do you find you can plant Criollo and keep it up, or have you gradually to revert to Forastero? We have in Jamaica a considerable tract of land in the western part where the remains of cacao are still found growing, and almost without exception the variety is Criollo. Some of these trees are said to be 100 years old and yet they are bearing heavily and doing well. But the question is whether the seeds from these trees can be utilized for establishing new estates of pure Criollo. With reference to the question of Criollo growing well and being supplied where it is already established, we wonder whether a system of budding on strong stocks would not apply. For instance, on estates in Venezuela, where they found they could not successfully establish Criollo in vacant places and have had to plant Forastero instead, would it not be possible to bud on the Forastero from their Criollo trees? We have been experimenting with budding and found we can do it with success. Again, in our cacao estates we find many of the trees do not bear anything like as well as other trees, and we want to know whether we cannot improve them. Will it not be advisable to cut down those trees and bud on the shoot that springs up from one of the more valuable trees on the estate? Another matter we do not understand is shade. That seems to me to be a very complicated question. In Grenada they do not use any shade, and in Trinidad they use shade everywhere and find they cannot do without it. What is the reason? Is the shade wanted for the trees or the soil? If it is wanted for the soil, then you do not want shade trees, as the cacao will provide its own shade. Is it necessary to have shade at all, or is it a question rather of cultivation? Do the roots of shade trees keep the ground open, or might that be overcome by the use of cultivators? One of our most practical agriculturists in Jamaica started five or six years ago a cacao estate in the middle of the island, and he is convinced in his own mind that there it is necessary to have shade. But on the north side of the island it has been proved that shade is not required. I am inclined to think that shade produces moss on the trees and leads to fungus disease which might otherwise be avoided, and that the more sun you can reasonably allow to the cacao trees, the heavier the crop will prove.

Dr. H. A. A. Nicholls: The practice in Dominica is not to use shade, but trees are planted, in some cases running along lines, so as to serve as wind-breaks. I remember that fourteen years ago when I made my second visit to Trinidad

I was told that shade was necessary; so I obtained seeds of Bois Immortel from a friend, and planted them among my cacao. I was sorry I did so; but the hurricane, which did so much damage to the cacao estates in Dominica, did me some good in throwing down my Bois Immortel. The experience of the Dominica planter is that cacao grows better without shade than with it. I was exercised in mind a good deal by remarks made to me some years ago as to the advantages of a tree which is used here as shade. I was gravely told by some planters that the Bois Immortel is very beneficial, inasmuch as it gives out water from its roots during the dry season. We can well understand that such trees do good, but in a different way; their roots naturally would go further into the subsoil than the roots of cacao, and they draw from the subsoil certain constituents which will later on be shed upon the land in the shape of dead leaves and twigs and flowers, and so much nitrogenous matter would thus be supplied to the land in the form of humus. But we must also remember that these plants belong to the order called *Leguminosae*, which have nodules on the roots, and in these nodules are micro-organisms called bacteria, which have the power of drawing the nitrogen from the air and fixing it in the soil, and in that way nitrogen is supplied to the surrounding plants. It appears to me, therefore, that the benefits of the shade trees in Trinidad are not due so much to the shade, but to the manure they give to the soil.

Mr. E. M. DEFREITAS (Grenada): At one time we planted a great deal of shade trees in our cacao estates in Grenada. In fact we adopted the Trinidad system. After a time we found that the trees which were not shaded gave better results. Then about ten years ago planters began to cut down their shade trees, and at the present time, with perhaps one exception, I do not believe there is an estate in the island on which shade trees are grown. I have always been puzzled to know why in Trinidad cacao cannot be grown without shade. The soil here is somewhat different to that in Grenada; it is a stronger soil and has more clay. Having regard to the value of cacao cultivation, amounting to £900,000, and in view of the great difference between the yield here and in Grenada where we do not use shade, I think it would be advisable for the Imperial Department of Agriculture to carry out experiments in Trinidad with the view of finding out whether they cannot grow cacao here, as we do in Grenada, without shade. With regard to the question of improving the health of trees, we use sheep manure. We raise sheep not for mutton, but for the manure which commands a very high price on the local market.

The PRESIDENT: There is one point of difference between the cacao trees in Grenada and those in Trinidad. The trees in Grenada are much smaller and planted closer. The question is one of great importance—not for the Department—but for the planters of Trinidad. The Department will be happy to assist Trinidad in the same manner and to the same extent as the other islands. The wide question which Mr. Fawcett has brought up—whether as a general principle shade trees are necessary in cacao cultivation, can only be answered by trying

to find out whether in Jamaica they want shade trees at all, or want shelter belts. It would be useless to follow blindly the experience of Grenada and Trinidad, because the circumstances of the two places are so different from those of Jamaica. In Jamaica they are liable to hurricanes, whereas in Trinidad and Grenada they are not. I believe in Dominica and the Northern Islands they grow the 'Pois doux' (*Inga dulcis*).

Dr. H. A. A. NICHOLLS: They use it for shelter belts, not as a shade tree.

The PRESIDENT: I should like to ask Mr. deGannes what he regards as an average yield either per tree or per thousand trees in Trinidad?

Mr. J. G. DEGANNES: Twelve bags, of 170 ℔. each, to each thousand trees planted 12 feet apart.

Mr. E. M. DEFREITAS: The average yield in Grenada is 4 bags, of 196 ℔. each, per acre.

The PRESIDENT: So far, we have had no experience as to the relative values of Criollo and Forastero.

Mr. J. G. DEGANNES: Criollo was put aside altogether because the yield was poor: it is a delicate tree for Trinidad. I understand that even in Venezuela there are certain parts of the country where it does not thrive at all.

The PRESIDENT: Would it be any advantage to graft the Criollo on to the Forastero stock?

Mr. J. G. DEGANNES: It might be tested on a practical scale.

Mr. J. H. HART: Our experience with grafting is very small at present. The Forastero is the strongest-growing cacao, but the Criollo produces a cacao of the highest quality. The question of shade, I think, might be usefully gone into. I have discussed it many times and have come to the conclusion that shade is absolutely necessary for Trinidad. I am equally certain that shade is not necessary for Grenada. I have heard the story of a Grenada planter who came to Trinidad to teach the planters here how to grow cacao without shade. He bought an estate and carried out the experiment by cutting down all the shade trees with the result that he had to replant them, as he found it impossible to grow cacao here without shade. If ever you see a bad patch of cacao here the planters' explanation is that the trees have not sufficient shade.

The PRESIDENT: I should like to suggest for the consideration of the Agricultural Society whether during next year they could put an acre of the Criollo variety of cacao in cultivation. The results might be sufficiently reliable to justify an extension of it later on, or to abandon it altogether. I know Mr. Hart would be willing to join in an experiment of that sort, and it would be useful to the colony.

Dr. H. A. A. NICHOLLS: Mr. Hart has declared, *ex cathedra*, that cacao cannot be grown in Trinidad without shade trees. I do not think the argument used by him fully warrants that declaration, because one can very well understand that cutting down shade trees from among cacao trees brought

up with shade, is very different to growing cacao trees up to maturity and then cutting down the shade. The proper test as to whether cacao can best be grown in Trinidad with or without shade is to endeavour to grow cacao with and without shade right from the seed. I do not think that has been done as yet in Trinidad.

Professor P. CARMODY (Trinidad): I would like to make a few remarks in connexion with this subject as I have given a little scientific attention to the shade tree used in Trinidad. Mr. deGannes, who is an experienced planter and works his estate himself, will tell you that cacao cannot be grown in Trinidad without shade. It is natural to assume that when cacao trees were first planted here no shade was tried, but it was subsequently resorted to in consequence of failure. It seems to me unreasonable to suppose that a man would begin to plant Immortel trees before he knew they were required and then plant cacao. I incline to the opinion of Mr. Howell Jones, that the question of shade or no shade depends upon local circumstances. From analyses of the flowers of the Immortel tree made in 1901, I ascertained that some of them contained as much as 6 per cent. of nitrogen calculated on the *dry* flowers. This large percentage naturally attracted my attention and further investigation was made which led to a report to the Government.*

Mr. J. G. DEGANNES. About forty years ago a gentleman came here and started cacao cultivation. His idea was that we were making a mistake in planting shade trees. He planted cacao, raised with temporary shade, and then cut down the shade. When the shade was removed the cacao trees stopped growing and he lost everything.

Dr. VAN HALL (Dutch Guiana): In the question of shade trees we are just in the same position as planters are here in Trinidad. There is a general idea that cacao cannot be grown without shade in Surinam. There is only one estate where it is grown without shade. One thing of great importance with that estate is that it can be irrigated in the dry season. On other estates, where attempts have been made to grow cacao without shade, the trees generally suffer very much when the dry season comes. In my opinion it is very difficult to grow cacao without shade in Trinidad; when grown without shade it must be cultivated in another way. First your soil must be better tilled when no shade tree is used, because the shade tree is an improver of the soil and when you lose such an improver you must do yourself what is more or less done by the tree. Another thing planters do not understand is this: the shade tree is also a windbreak, and when you remove the shade you must take care that your trees are in sheltered position. Then the question of irrigation is, in our country also, a matter of importance. If you do not use shade trees and do not till your soil better, the soil suffers from drought in the dry season, and irrigation

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will be necessary to keep your cacao trees alive. It is not necessary in plantations where there are shade trees. These and similar matters are often overlooked by planters who try to grow cacao without shade. Another thing is this. As in our country, where the wet season is followed by three very dry months, you have to remove your shade trees not at once but gradually; and that is perhaps one reason why the experiments which some planters tried were unsuccessful. My Department is now trying an experiment with young trees. We have removed the shade from a field of about 2 acres, leaving some wind-breaks, and the first year, at any rate, this was a success, because, contrary to the expectation of many planters, when the dry season came none of the trees suffered. In the second year, however, we had a very bad dry season and the trees suffered more or less. Yet planters were very astonished that they were still in good condition. It seems to me that once shade is properly removed, cacao can be grown in Surinam without shade.

CACAO CULTIVATION AND GREEN DRESSING.

Dr. FRANCIS WATTS (Leeward Islands): The question of the treatment of orchard soils was brought up at the previous Conference, when I put forward views urging in substitution for excessive tillage and keeping the land clean in orchards, the adoption of a system of green dressing, or the use of weeds and shrubs for manures. This has all along existed in Dominica. The weeds are allowed to grow, and at intervals these are cut down without materially disturbing the surface soil; the cuttings are either used as a mulch, or they are treated as a green dressing and bedded in. The crop that has been found most useful so far appears to have been woolly pyrol. I have had some experiments made with other plants, but not to a very great extent. I have recently put forward some analyses which I believe will appear in the next issue of the *West Indian Bulletin* [Vol. V, pp. 287-8] showing the proportion of manurial constituents which may be returned to the soil on each cutting. This is very largely practised in Dominica especially where it is shown that the amount returned is very considerable. I have had occasion at certain times to examine soils. I will take one case, namely, Frenches, where Mr. Scully follows this system of cultivation. Around each tree he keeps a space of about 10 feet perfectly free from weeds; the remainder of the land remains largely untilled; the weeds are cut down and either are left as a mulch to find their way into the soil, or are at once dug in. I think it would be wrong to allow the formation of anything approaching a permanent grass sod: and perhaps that is the point where I find the greatest conflict of opinion. I think all agree that the surface of the soil must be light, loose, and free—nothing like a definite grass sod. There are some places in Dominica where in cutting down into the soil one finds the conditions of natural virgin soil: the condition of tilth is maintained thoroughly. The great point is draining. On that subject I may have more to say at a future period. In

Dominica it is a recognized method of cultivation, a cheap one, and a very thorough one, and I think it would be found better in practice, and tend to solve some of those difficulties to which Mr. Fawcett has referred, than keeping the soil absolutely clean. I have seen many cases where attempts have been made to keep the land perfectly clean and where the highest perfection used to be the absence of every weed ; but in most cases I think that has been found to be most disastrous : the soil bakes hard and then a system of forking has to be resorted to.

ARTIFICIAL DRYING OF CACAO.

The desirability of drying cacao by artificial heat, thereby rendering the planter more or less independent of atmospheric conditions, has long been realized in the West Indies. During wet seasons and in certain elevated districts of some of the cacao-producing islands considerable loss is frequently occasioned by 'mildew.'

Mr. G. Whitfield Smith, then Travelling Superintendent of the Imperial Department of Agriculture, gave a brief sketch in the *West Indian Bulletin* (Vol. II, pp. 171-4) of the efforts that had been made in Grenada to dry cacao by artificial heat, and gave, also, a description of a cacao drier since erected by the Department at the Botanic Station, Dominica. A further description of this drier will be found in the *Agricultural News* (Vol. I, p. 19) where it is stated :—

'The essential feature of this drier is the arrangement by which the hot air, on entering the drying box, is conducted along an air-tight flue or channel, and *is compelled to pass over and around the trays in succession*, beginning with the lowest In this respect it is a great improvement on driers of a similar pattern used in Grenada and elsewhere, which have no interior divisions. In such driers it is found that the hot air on entering the single drying chamber naturally rises to the top, with the result that the beans on the upper tray were too quickly dried, while those on the lower tiers were only partially dried or, in some cases, remained moist.

'The drier above described is capable of dealing with 5 bags of cacao at a time, and its original cost, including shed, stove, and fan, was £127. Where, however, the planter is able to utilize a spare building in which to place the drying box and stove, the cost might be reduced by about one half.

'For the information of those desirous of erecting a similar drier, it may be mentioned that the fan (18 inches) with belt and driving wheel might be obtained from the Blackman Ventilating Company, Limited, Head Office, 68, Fore Street, London, E.C., at a cost of £9 6*s*., and the stove (Motts' Comet No. 28) from the I. L. Mott Iron Works, New York and Chicago, at a cost of £10 17*s*. 3*d*. The latter is surrounded by a galvanized iron jacket to confine the hot air and to discharge it through the cowl into the drying box. The fuel may be wood, coke, or coal, as found most convenient.'

Subsequent trials have shown that cacao can be dried within twenty-four hours of being placed in the drier without

the fan being worked after 9 o'clock at night. The best results were obtained by maintaining a temperature of 110° to 120° F., with a good draught passing over the beans. Similar driers have been erected on private estates and have proved thoroughly successful. As many as 9 bags have been cured in twenty-four hours.

The members of the West Indian Agricultural Conference of 1905 had an opportunity of inspecting a patent cacao-drying apparatus erected by Mr. Hoadley at Chaguanas, Trinidad. The following is a description of this drier:—

The cacao-drying apparatus consists of an ordinary room 34 feet square, with 25 feet perforated circular drying floor, upon which cacao is placed direct from the fermenting box. In the centre of the drying tray is a vertical axle from which project four arms which are revolved once in ten minutes. To each arm are attached six ploughs, the operations of which are equal to the work of twelve coolies in keeping the cacao in constant motion. Hot air is generated by exhaust steam, which is passed into 1,100 feet of piping enclosed in a box, over which cold air is drawn by a powerful fan which makes from 600 to 700 revolutions per minute. The air in its passage becomes heated to any desired point up to 150° and is forced up through the drying floor. The machine will dry from 12 to 15 bags of cacao in thirty to thirty-six hours. The cost of installing the system is said to be between £300 and £400.

After drying, the cacao is passed through a machine which clays and polishes, or merely polishes to suit the markets, and thereby saves the costly process of dancing.

The cacao is fermented in cylindrical drums, which are partially turned every night and morning for ten to eleven days.

APPENDIX.

The Immortel as a Shade Tree for Cacao.

The following is the report on the manurial value of the flowers of the Bois Immortel (*Erythrina umbrosa*) referred to by Professor Carmody (see p. 77):—

I have the honour to report that an analysis of the above flowers shows them to contain a remarkably high proportion of nitrogen, viz., 6 per cent., and to be therefore of considerable manurial value.

2. My attention has been drawn to this tree by various proposals made from time to time to replace it by other shade trees, the timber or other product from which would be saleable and therefore presumably more profitable to estate owners.

3. It would be contrary to usual experience to find that successive generations of planters would cheerfully incur the additional expense of cultivating these trees unless there were

some compensating advantages discernible in practice but hitherto incapable of being estimated on any definite basis.

4. It appeared to me remarkable that a shade tree should have been chosen differing so strikingly from the majority of tropical trees, in the luxuriant profusion of its annual harvest of flowers, and that, possibly, its inherent value could be traced to this difference. This led to the analysis of the flowers.

5. Flowers decay so much more rapidly than leaves that the organic nitrogen they contain is readily converted into an assimilable form.

6. It is probable that all the nitrogen in the flowers is derived from the soil. But in collecting the nitrogen from the subsoil, and by means of the flowers bringing it annually to the surface, the action of the Immortel would clearly be beneficial in this climate. There is also the possibility that the decomposing flowers may renew or assist soil nitrification.

7. So far as I know the flowers of the Immortel have not hitherto been analysed for their manurial value.

8. The results of this analysis have confirmed my opinion in favour of retaining the Immortel as a shade tree for cacao which requires an abundance of nitrogen in the soil.

A later report runs as follows: -

Last year in Agricultural Society Paper, No. 155, it was shown that Immortel flowers were particularly rich in nitrogen, and it was estimated that they contributed to the soil a larger amount of this substance than was permanently withdrawn by the cacao bean. This year the investigation has been continued, and, through the kind co-operation of Mr. J. G. deGannes, we are able to give a more accurate estimate of the nitrogen supply from these flowers. Mr. deGannes' valuable report is attached.

This year we have not found any of the samples to contain more than 4·03 per cent. of nitrogen which is considerably less than the 6 per cent. found in last year's samples.

Taking Mr. deGannes' figures and ours (reduced to 3 per cent. to be within safe limits) the following calculation is made:—

50 Immortel trees = 800 lb. *dry* flowers
at 3 per cent. of nitrogen = 24 lb. per acre.

250 Cacao trees = 500 lb. cured cacao
at 2½ per cent. of nitrogen = 12½ lb. per acre.

This shows an excess of about 12 lb. of nitrogen per acre.

Apart from the question of the retention of the Immortel as a shade tree, which we submit these figures fully justify, the results of this investigation suggest that flowering trees may be utilized to keep the nitrogen of the soil in circulation, and to conserve it by bringing it from lower depths in a soluble form and periodically spreading it in a less soluble but easily decomposable form on the surface of the soil.

It will be remembered that last year it was stated that the amount of nitrogen in the flowers rapidly diminishes. We

now find that this depends on the methods of storing the samples, and that if the flowers are spread out thinly, instead of in heaps, there is no loss of nitrogen even when freely exposed for several days to the air.

We now wish to bring to the notice of the members of the society another point which appears to us to be in favour of the retention of the Immortel in preference to other shade trees. It has long been observed that the Immortel drops its leaves during the dry season, and it has been stated to its discredit that it ceases to give the necessary shade at the time when the cacao trees most require it. It should not be overlooked that one of the functions of the leaf is to evaporate water in large quantities, and in the absence of leaf there must be absence of evaporation. The water evaporated is drawn from the soil by means of the roots, and it follows as a natural consequence that a leafless Immortel tree does not absorb from the soil that large amount of water which its leaves, if present, would have evaporated, and that this water remains available for the cacao trees which are never entirely leafless. The value of this self-denial on the part of the Immortel during the dry season, when for four or five months the rainfall is very low, has, we think, not been fully appreciated.

With reference to the previous paper on this subject Professor Carmody has been reminded that he cannot claim to be the first to point to the flower as the special and most valuable feature of the Immortel as a cacao shade tree. At the time of writing the paper he believed he was alone in giving expression to such an advanced opinion; but he is glad to find that one of the most astute observers among our cacao planters, viz., Mr. J. P. Bain, has long held and expressed the same view.

Mr. deGannes' report, dated April 7, 1902, is as follows:—

The Immortel tree ('Anauca') from which I collected the flowers, is an isolated tree and was profusely laden with healthy flowers at the time, but its size is rather below the average full-grown trees. I must here remark that the 'Anauca' does not thrive its best in the Vegas. I had the land underneath the tree properly cleaned, and the flowers were collected carefully and weighed twice a day. The quantity collected amounted to 130 lb., but a good many were blown away by the wind outside of the area cleaned, and I think by adding 30 lb. to the quantity collected, making 160 lb., would be as nearly as possible correct. I regret I did not collect flowers from the 'Bocare,' it escaped my memory to do so when the trees were flowering, but it is my impression that, as they do not bear so profusely as the 'Anauca,' the weight per tree is less notwithstanding the size of the flowers being larger.

Nitrogen Content of Immortel Flowers, 1901.

Flowers.	Percentage of			Total Nitrogen calculated on flowers dried at 100° C.
	Water.	Ash.	Organic Matter.	
				Per cent.
Immortel leaves. Anauca.	12·44	12·48	75·08	2·87
„ flowers.	14·44	10·12	75·44	4·05
„ „	81·32	1·48	17·20	6·30
„ „ (Botanic Gardens)	77·44	...	...	4·21
„ flowers. Anauca. (Cascade Valley)	84·84	...	...	4·81
„ flowers. Anauca. (Tortuga, fresh)	89·88	1·00	9·22	6·32
„ flowers. Anauca. (Tortuga, 2 days old)	83·36	...	...	5·16
„ flowers. Anauca. (Tortuga, 5 days old)	14·44	...	...	4·14
„ flowers. Anauca. (Tortuga, 6 days old)	14·04	...	...	3·91
„ flowers. Bocare. (Cunupia, 2 days old)	83·58	1·36	15·06	4·94
„ flowers. Bocare. (Caroni, fresh)	91·16	...	...	3·84
„ flowers. Anauca. (Caroni, fresh)	86·18	...	...	3·25

Nitrogen Content of Immortel Flowers, 1902.

Flowers.	Percentage of Water.	Percentage of Ash.	Percentage of Organic Matter.	Total Nitrogen calculated on flowers dried at 100° C.
				Per cent.
Anauca (Chaguanas)	86·20			2·46
„ (Tacarigua)	86·16			3·25
„ (Santa Cruz)	89·99	1·06	8·95	3·25
„ (Belmont) .. .	91·19	0·85	7·96	3·52
„ (Cascade)	90·59	1·12	8·29	2 65
„ (Siparia)	86·85			4·03
„ (Pool)	91·14	0·94	7·92	3·29
„ (Tortuga)	88·22			3·25
Bocare (Chaguanas)	91 06			3·13
„ (Maraval)	90·83	1 03	8·14	3·92
„ (Siparia)	91·42			3·61
Buds.				
Anauca (Santa Cruz)	87·17	1·57	11·26	3·74
„ (Tortuga)	87·10			3·21

Summary.

1901.	Nitrogen calculated on flowers dried at 100° C.	1902.	Nitrogen calculated on flowers dried at 100° C.
	Per cent.		Per cent.
Lowest results ...	3·25	Lowest results ...	2·46
Mean	4·63	Mean	3·40
Highest	6·32	Highest	4·08

FUNGOID DISEASES OF CACAO.

BY L. LEWTON-BRAIN, B.A., F.L.S.,

Mycologist on the staff of the Imperial Department of Agriculture.

Most of the principal cacao diseases have been fully dealt with at previous Conferences. There remains only to summarize the chief facts with regard to the fungi causing these diseases and to mention the chief methods of dealing with them.

STEM DISEASES.

Among stem diseases the two most important are the 'canker' due to *Nectria* and the 'die-back' due to *Diplodia cacaoicola*.

Canker.—Canker is certainly met with in Trinidad, Grenada, and Dominica. I have not seen specimens from St. Lucia, though it may occur there.

The disease is first recognized by a gummy exudation from the bark at the point attacked. The underlying tissues are discoloured and soft. The canker may spread quickly round the tree or may extend in all directions, in which case the death of the tree is slower.

The fungus causing the disease is a wound parasite. The first point then in dealing with it is to care for wounds, both those made in pruning and accidental ones; knives or cutlasses, that have been used in cutting out diseased wood, should be cleaned before being used for pruning other trees. Wounds should be thoroughly tarred over. In pruning, care should be taken to cut close to the main stem and to leave a smooth, sloping surface.

Dead trees should be cut down to the ground and the wood burnt. All dead branches and twigs should be removed and destroyed, not allowed to lie about on the ground and rot there.

If taken in the earliest stages, the diseased bark and wood may be cut out with a sharp knife, taking care to get rid of all the diseased tissue. The wound should, of course, be tarred over. I should like to see a trial made of treating the cut surface first with Bordeaux mixture and, when this is dry, tarring.

Die-back.—The die-back disease is also extremely common in some, at least, of the islands. It certainly occurs in Dominica, St. Lucia, and Grenada.

The disease starts in the younger twigs and spreads from these to the larger branches, the fungus advancing in front of the dying bark. The spores of the fungus are formed in chambers in the bark and break through as black pustules.

The fungus is a saprophyte and can live on dead cacao wood. To remove this source of infection should be our first care.

The disease does not readily attack healthy vigorous trees. Perhaps this is the reason why it is not recorded in Trinidad, though the fungus occurs here. Every effort should therefore be made to attend to the health of trees. Cultivation of the soil, manuring, and drainage should all be seen to. Dr. Watts, I know, regards the question of subsoil drainage as of the greatest importance in Dominica, and I regard it as certainly most important as regards this disease.

Diseased twigs and branches should be cut out and burned.

All wounds, as in dealing with canker, should be tarred; in fact careful treatment of wounds and careful pruning are of the utmost importance to the cacao planter. I quite agree with Mr. Hart's and Dr. Nicholls' remarks on this point.

POD DISEASES.

There are two principal pod diseases of cacao in the West Indies. One is the brown rot caused by the same fungus as the die-back disease of the stem: the other is the rot caused by *Phytophthora omnivora.*

Brown Rot.—The brown rot due to *Diplodia* occurs in, I believe, all the cacao-producing islands of the West Indies. It starts as a brown, circular spot, usually either at the basal end of the pod, or at the free end; it may, however, start at any point where the pod has rubbed against a branch and so caused an abrasion. The decay rapidly spreads to the interior of the pod and this dries up altogether. Finally, the whole pod becomes black from the numerous pustules of spores, which break through the surface.

As I have already mentioned, *Diplodia* is a facultative saprophyte. Great care should therefore be taken to bury all husks and shells as soon as possible.

Ripe pods showing the small, brown, diseased areas should be picked at once to save as many beans as possible. Badly diseased pods and any refuse showing the *Diplodia* fruits should be removed and burnt.

Phytophthora.—The pod rot due to *Phytophthora* occurs certainly in Trinidad and St. Lucia and is reported from British Guiana. The attacked pods are covered with the white mycelium of the fungus, which produces abundance of conidia. These are carried by wind and rain to other pods which they quickly attack. The mycelium spreads also to the interior of the pod which turns black and decays. Inside the pod are found the resting spores of the fungus, the oospores, which are only liberated with the decay of the fruit.

All diseased pods should be collected and buried as soon as possible in order to destroy the resting spores of the fungus.

Too moist and shaded an atmosphere should not be provided for the developing pods, as this favours the growth of the fungus. A severe epidemic of the disease could be checked by spraying the unattacked pods with Bordeaux mixture after the removal of those showing the disease.

As you have already heard, these methods have been adopted with great success in Trinidad.

THREAD BLIGHT.

Occurrence.—Up to the time of the Agricultural Conference this disease had only appeared on, or rather been reported from, one estate—the Fond estate in St. Lucia. Since that time Mr. Leslie, Agricultural Instructor in Trinidad, has forwarded specimens of cacao from Parseverance estate, near Sangre Grande, in that island, which were attacked by the same disease. It was first noted in May and June last year when specimens were forwarded from St. Lucia for examination by Mr. John F. Branch, the manager of Fond estate. I have not seen the disease *in situ*, and my remarks on its field characters must be taken as second-hand. Mr. Branch considers that he has two diseases, but whether this is so or not I cannot definitely state at present; in many respects the two are alike, and they appeared at the same time and in the same locality.

I intend to speak primarily on the more serious disease or form, which I label the 'thread blight.' The other disease, I may call the 'horse-hair blight.'

On the receipt of these specimens inquiries were at once made in all the other cacao-producing islands of the West Indies, to find out whether the disease occurred in any of these. A note on the disease, also inquiring for information as to its occurrence, was published in the *Agricultural News*. The answers were, in every case, negative.*

Similar diseases, on tea, occur both in India and Ceylon. The 'thread blight' in India is said to be caused by *Stilbum nanum*, the 'horse hair blight' by *Marasmius sarmentosus*. The 'thread blight' has been known for many years, but it is only recently that the fungus has been identified. Both diseases are regarded as being of very serious effect.

The only information I have on the effects of the disease is contained in letters from Mr. Branch. I quote the following with regard to the 'thread blight':—'It is of a very serious nature, as it destroys the whole tree and is very difficult to get rid of. It runs along at the back of the branch and destroys every leaf and young shoot it touches. I believe it is the most serious cacao disease we have to deal with.'

In Trinidad the disease is said to have appeared on only a few, unhealthy trees: whether they were unhealthy before being attacked, or on account of the disease, is not stated.

Symptoms.—The appearance of the disease is very characteristic and there is no chance of mistaking it for anything else. The fungus appears as dark-brown threads or strands, closely adpressed to the bark. These strands run an irregular course up and down the twigs, branching irregularly, but

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* Quite recently Mr. A. W. Bartlett, Government Botanist in British Guiana, has reported the discovery of this disease on a neglected estate on the Demerara river. Here also, as in Trinidad, the disease is not regarded as being very dangerous.

especially when they come near a leaf or a bud; the general course of the strands is along the twigs and branches. So closely are the strands attached to the bark that they cannot be removed without tearing this away. When young the threads are white and thin, thickening up and darkening after they have attained a good hold on the bark.

Occasional swellings on the threads were found in the Trinidad specimens. These were at first taken for reproductive bodies, but on examination were found to be simply masses of mycelium.

When a thread touches a bud it spreads out and branches, so that the bud becomes covered with a white felt. The thread also passes along the short petioles of the leaves, and when it reaches the base of the lamina, branches and spreads, at least at first, along the main ribs. On the leaves it grows on the under side, where it is shaded. I have not received advanced stages of the fungus on the leaves but I judge that, like the Indian 'thread blight' of tea, it expands over the under surface and causes the leaves to turn brown and ultimately to decay. Certainly, according to Mr. Branch and others who have seen the disease in the field, it kills the leaves fairly quickly.

The 'horse hair blight' is pretty well described by its name. Its appearance resembles nothing so much as a tuft of horse hair caught in the twigs. Closer examination of course shows that the apparently single hairs are really all branched and interwoven together in a very complex manner. Here, also, some of the threads are closely attached to the bark. The hairs have much the same structure as the strands of the 'thread blight.'

Microscopic Examination.—Microscopic examination of the strands shows at once that they are composed of closely woven, but, for the most part, parallel-running, hyphae. The hyphae are narrow and septate. In the young strands the hyphae are white and delicate and not so closely united. As they become older, the hyphae, and especially the outer ones, become darker and thicken their walls.

From the under side of these strands numerous single hyphae run off into the bark of the cacao twigs. In the first place these hyphae serve the same purpose as the adventitious roots of the ivy, namely, act as holdfasts; by growing in the crevices of the bark they attach the strands so firmly that, as I have said before, the strands cannot be removed without tearing the bark.

In an old branch with a well-developed secondary cortex and cork layer this is all I have been able to see these hyphae doing. They do not seem able to penetrate through a well-developed cork. The hyphae in this case live and attach themselves to the dead tissues outside the cork.

The case is different when we come to young, green twigs without a good cork layer. In this case the hyphae pass through into the living cortex and branch and interweave there in all directions until the cortical tissues are completely destroyed. We then find in their place a closely interwoven

web of fungal hyphae. Not only so, but hyphae also pass into the medullary ray cells and even into the wood. In the main, however, the fungus is a parasite of the cortex and does not injure, to any great extent, the internal tissues.

This resistant power of the cork explains the point on which Mr. Branch lays stress, in the letter I have already quoted, that it is the young shoots that are killed by the fungus.

The hyphae also penetrate into the interior of leaves and into the tissues of the buds. Both leaves and buds are killed out by the fungus.

The damage done by the 'thread blight' is thus pretty severe. It can destroy all the growing points and young twigs, and more than this, can reduce assimilation by killing off the leaves.

Origin.—The next point to be considered is the origin of the parasite, but I have not yet been able to get any definite information as to this In all probability the fungus is parasitic on wild plants, in the bush, and I understand that the part of the estate where the disease first appeared is near wild forest or bush land. The following is taken from a letter from Mr. Branch answering a question of mine with regard to the position and conditions of the diseased area: 'The diseased trees are growing in a very healthy field about 500 to 600 feet above the sea-level. The field is not quite flat but gets a good rainfall, and is frequently pretty damp. There are no forest trees overhanging or very close to the diseased trees. These are limited in number.'

In India the 'thread blight' is known to occur on several wild trees, and spread from these to the tea bushes. It will probably be found that the same is the case in St. Lucia, and that the fungus is not at all particular in its choice of a host plant.

Spread.—The fungus spreads by means of its mycelium attached to bits of dead twigs, leaves, etc. In all probability the leaves are the most important in this connexion. When they are dead and covered with the fungus mycelium, they will easily be blown or otherwise carried about. If then they are caught on the branch of a healthy tree, especially in a moist locality, this will soon be infected. Other pieces of infected material will act in the same way.

In the case of the 'horse hair' disease it is probable that birds, using the strands for nest-building, may carry the disease from one plant to another.

Treatment.—By means of thorough and constant pruning and the destruction of diseased material, I am informed that Mr. Branch has kept the disease under. When the disease is noticed in time, this treatment, if thoroughly carried out, will probably be sufficient to eradicate the disease.

When pruning to this extent would have to be too severe. I have recommended the use of a lime-sulphur wash. This is prepared by slaking 7½ lb. of quick lime, mixing with 2½ lb. of sulphur, making up to 10 gallons with water, and boiling

until the mixture turns orange in colour, and takes on a strong smell of rotten eggs. This mixture is well rubbed into the affected parts with a brush. I have no information as to whether this wash would be successful with cacao 'thread blight', nor as to its effect on the bark of the tree itself. It has been used on tea in India with very good results.

Identity of Fungus.—It is impossible at present to identify the fungus causing the 'thread blight.' This, of course, can be done only when reproductive organs of the fungus are found. This may be a matter of years, as it is probable that the fungus will go on growing vegetatively indefinitely without ever forming spores. From the characters of the mycelium I should say that the fungus is a *Basidiomycete*, that is, one of the toad-stool-bearing fungi.

Danger of Neglect.—The last point I wish to touch on is the danger of neglect. The disease is a serious one, and once established would be difficult to deal with. Had Mr. Branch not noticed the disease when it first appeared, it might easily have spread over his whole estate, and he is certainly to be commended for his promptness. It is of the utmost importance that the blight should be taken in hand as soon as it appears, in which case it can easily be dealt with. The following quotation from Watt and Mann's book on *The Pests and Blights of the Tea Plant* will emphasize this:—'Thread blight has been one of the most common and perhaps one of the most destructive blights of the tea plant. Until recently, it was usually neglected and laughed at as doing little or no harm. The result of this is seen in the fact that 20 to 50 per cent. of the bushes in a block were not infrequently affected, thus reducing the yield and ruining bushes.'

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DISCUSSION.

The PRESIDENT: A very serious disease has appeared in Surinam called the 'witch broom' disease, which reduces the crop to a great extent. I do not know if that disease is in British Guiana,* but I should be glad if specimens were sent to us. In connexion with this disease I have recommended to the Governments in the West Indies that precautions should be taken against the importation of portions of cacao trees from the mainland of South America, because it would be a very serious matter if the disease were introduced into plantations in Trinidad, Grenada, and the Northern Islands. I should be glad to hear a few words from Dr. van Hall as to the nature and extent of the disease, and what steps are taken to combat it.

Dr. VAN HALL (Dutch Guiana): The 'witch broom' disease is very widely spread in Surinam. It began with estates lying near the coast; estates in the interior suffer much less. The disease is a very serious one, inasmuch as it attacks not only the twigs but also the pods. Black spots appear on the pod, they soon spread, and the pod remains small. That form of the disease is the worst, because sometimes 50 per cent. of the pods are diseased. The disease of the twigs does not seem to be so serious, and if we can keep the pods in a healthy condition I think we shall have gone some way in the direction of checking the disease. The soil in Surinam is very fertile and when the diseased branches die in the dry season, the tree soon makes new branches, therefore I do not think the damage of the twig disease is very great. To get rid of the disease we are now making experiments in two directions. First, pruning the trees thoroughly, and in that way removing all diseased branches, because we find that the mycelium is not only in these hypertrophied branches that are called diseased, but also in the bigger branches to which the small twigs are attached, and also through the wood, so that the measures formerly adopted by the planters, of only removing the twigs which seemed to be diseased, were not enough. The branches and twigs so removed are carried out of the plantation and burnt. At the same time good tillage of the soil, digging in the dry leaves, is also a measure that must be practised. The second series of experiments was spraying with Bordeaux mixture. That had been adopted by the planters, but not in a proper way; they began to spray too late, and so spraying has had no beneficial result. The infection of the buds begins earlier than was thought. When you see the black spots appear on the pod, the pod has been infected for a long time. It seems to me that the pod is liable to be infected when very young, therefore in the experiments now being carried out we begin to spray before flowering when the buds first appear; and it does not seem to affect the pods. The first spraying is

* The witch broom disease has recently been recorded, by Mr. A. W. Bartlett, on one estate in British Guiana. The estate had been badly neglected and the disease has spread through the whole cultivation.

done before or when the pods appear, and afterwards we spray two, three, or four times. We do not know how often spraying must be done to prevent infection reaching the pods. These experiments were only begun this year, and therefore we shall not have any results until March or April, which is the time when the disease appears on the pods. I anticipate good results, however, because, although spraying in the last season was commenced too late, I may mention that the percentage of diseased pods on trees which were sprayed was 17 per cent., while on unsprayed trees it was from 40 to 50 per cent.

Mr. G. S. HUDSON (St. Lucia): In discussing the 'thread blight,' Mr. Lewton-Brain has dealt chiefly with what I have termed in the specimens before me, form no. 2 of this disease. It is necessary to make a distinction, for there is another form of this disease characterized by a totally different appearance and habit, the distinctive feature of which is the appearance of tough, horse-hair-like filaments externally following the direction of the smaller twigs in the upper branches of the tree when first attacked. I have called this form no. 1, because, wherever I have yet observed the disease, this horse-hair form is much more prevalent than the white blight form, and were it not for the fact that one is never found without the other, the casual observer would be very much inclined to class them as two separate diseases. I am happy to say that the occurrence of this disease in St. Lucia is exceedingly rare; it has only been observed on two forest estates, the cultivation of both of which had, until lately, been very much neglected: in fact, the cacao trees attacked were, until lately, practically uncultivated. It was first observed about six months past, and a vigorous pruning of all the affected branches has proved so efficacious that on visiting these two estates a fortnight ago to obtain specimens for this Conference I was unable to find any cacao attacked by this disease, and I therefore searched for its appearance on forest trees adjacent to the previously infected plantations with the result that I obtained the specimens now before me, which were cut from *Inga vera* (called 'Pois doux' in the local patois), *Calyptranthes sericea* (known as 'Bois de Basse'), an unidentified forest liane, and another forest host known locally as 'Bois creole.' This list by no means comprises all the forest hosts of this fungus which appears to be almost omnivorous. On the affected area, and also on cacao trees, it is noticeable that the white blight absolutely and quickly kills every branch or twig it attacks, while the horse-hair symptoms do not appear to be very deadly. Both forms attack from above and extend upwards, thus limiting damage. Form no. 1. of this disease is easily recognizable by the conglomeration of dead foliage and twigs which are held up between the branches by the horse-hair filaments, which traverse them and prevent them falling, thus presenting a most unusual appearance. I consider it highly necessary that every cacao planter should familiarize himself with the appearance of this disease in order that it may be prevented from getting a firm footing in cacao plantations.

Note Added:—

The following letter has been received from the Hon. B. Howell Jones in reference to the 'thread blight' disease of cacao:—

'On my return to Demerara I mentioned the thread disease on cacao that had been found in St. Lucia, and also showed a specimen that had been sent me by Mr. Lewton-Brain from Barbados, and I have received a letter from a gentleman here of which the following is an extract which may interest you: "In yesterday's paper I see you have brought a specimen of what you call thread disease; according to the description given of it, I should say it is the same thing that attacks the tea bushes in Cachar, India, and which there passed under the name of Thread Blight; the Indian Tea Association, Calcutta, would give you full particulars about the blight. I remember in 1901 it was very bad in the Bengal United Tea Co., Amakall Division, where I was for some years. We found it more prevalent in badly drained places; we found good cultivation and an application of a solution of Phenyle to the stems a good thing."'

ADDENDUM.

Witch Broom Disease in Surinam.

A short account of this disease has already appeared in the *West Indian Bulletin*, (Vol. II, pp. 289-91).

Dr. C. J. van Hall, the Director of Agriculture for the Dutch West Indian Colonies, has kindly forwarded the following additional information in regard to this disease in Surinam. Dr. van Hall's account of the experiments initiated by his Department will be read with interest:-

The first experiments on a large scale, as well as the laboratory work, were started in September last; we have therefore been actually working only for about eight months, and it is not surprising that as yet we have obtained no definite results.

Symptoms of the Disease.—These are well known now. The branches and the fruits are affected. The twigs are without doubt affected when in the bud state; the result is:—(*a.*) a hypertrophied growth; (*b.*) a tendency towards making many side branches ('Witch broom').

When the young fruits are affected they frequently show a small hunch, but often the trained eye only of the planter is able to detect it. In other cases the fruits keep their normal form, but show at first a discoloured spot, which, later (when the tissue dies) becomes *black*. When the disease first appeared in Surinam, there was much confusion between the 'black rot' disease well known in every cacao-growing country and the new disease; by cutting the fruit it is easy to decide whether it is 'black rot' or the new disease. Fruits attacked by the former are soft, those attacked by the latter are as hard as a stone; therefore the planters call this symptom 'petrifaction' of the fruits (Dutch 'Versteening').

The witch broom disease of the twigs is caused by the same fungus as the 'petrifaction' of the fruits.

Cause of the Disease. - The mycelium of the fungus is easily found both in diseased twigs and diseased fruits. It is characterized by its rather thick hyphae with granular contents.

The fungus is easily studied in pure cultures on all sorts of nutrient media. The simplest one is a decoction of ripe or unripe cacao seeds or fruits, with or without ½ per cent. peptone plus 1 per cent. cane sugar. I am not yet quite decided about fructification, and it would be imprudent to say anything about it. We have found a conidial fructification, the same both on diseased fruits and in our cultures, which we consider pure, but I want to see the whole development before I declare it to be the fructification of the parasite.

Treatment.—The first experiments consisted of spraying. The result showed that with spraying alone we could not succeed in keeping the disease sufficiently in check. We therefore began a new series of experiments, consisting of a combination of drastic pruning of all the infected parts and spraying. These experiments were started at the end of 1904, and extended to March 1905.

Although these experiments appear to have been successful, we must wait till the end of the dry season before drawing any conclusions.

INSECTS ATTACKING CACAO IN THE WEST INDIES.

BY HENRY A. BALLOU, B.Sc

Entomologist on the staff of the Imperial Department of Agriculture.

CACAO BEETLE.

(*Steirastoma depressum.*)

The cacao beetle is a very serious pest to cacao, sometimes causing the death of the trees. It is quite generally distributed throughout the West Indies and northern South America, where it is usually known as a pest when cacao is cultivated on a large scale.

The egg is laid in or on the bark of the cacao tree.

The larva or grub of the cacao beetle when full-grown is about 1¼ inch in length and ⅜ inch in width at its largest part. It is whitish in colour. The head is dark-brown, small and equipped with powerful jaws or mandibles with which it

tunnels its way through the wood. The segments of the body are prominent, giving the larva a wrinkled appearance. There are no legs or feet, but on the dorsal and on the ventral surface of each segment there is a small area, slightly roughened, which being pressed against the sides of the tunnel enables the larva to work its way along.

The pupa is formed in the tunnel made by the larva.

The adult is a black and grey beetle, about $\frac{5}{8}$ to $\frac{7}{8}$ inch in length, and $\frac{5}{16}$ to $\frac{3}{8}$ inch in width. The antennae are longer than the body, the segments swollen at their apical ends, the basal segment quite stout, the others slender. The head is broad; the thorax broad, flat above, with short, stout projections on each side. The wing covers are strongly ribbed longitudinally, and each is tipped with a short spine. The legs are long, the femora much swollen, the tibiae slender, the tarsal joints broad, flattened, and fringed with fine hairs. The ground colour is black, the grey being due to fine whitish scales which are easily abraded; a fresh specimen, consequently, is much lighter in colour than one that has been rubbed.

Life-history.—No observations seem to have been made as to the length of time spent in the egg, larval, and pupal stages, nor as to the season of egg-laying, and greatest abundance of adults.

Remedies.—The larvae and pupae may be dug out of the tree when their presence is known, or they may be killed by probing the tunnels with a stout wire. When any wounds are made in the tree, however, they should be promptly tarred over to prevent the entrance of fungi. The adult beetles are active by night, and may be found resting on the trunks and larger branches of the cacao tree in the early morning. At this time they may be collected, and if thrown into tins of water, to which a small amount of kerosene has been added, they will be quickly killed. In Surinam it is the common practice to tie large pieces of the bark of the silk cotton tree on the trunks of the cacao to furnish a hiding place for the beetles. They may be collected from these places during the day.

It would seem likely that strips of burlap (bagging) tied round the cacao trunks would have the same effect and furnish convenient places for collecting these beetles.

The cacao beettle is recorded from Venezuela, Colombia, Surinam, British Guiana, Trinidad, Grenada, and Guadeloupe.

CACAO THRIPS.

(*Physopus rubrocincta.*)

Cacao thrips was first reported as a serious pest in 1898 when it attracted the attention of cacao growers in Grenada. Since that time there have been several reports of damage due to thrips in Grenada, and it has been reported from other islands. While thrips is, without doubt, a pest of cacao and responsible for damage, it does not yet appear how serious

a pest it must be considered, nor has any complete account of its life-history been worked out.

In the matter of remedies and treatment, also, much remains to be done.

In December 1900 and in March 1901, Mr. Maxwell-Lefroy, then Entomologist on the staff of the Department of Agriculture, visited Grenada to investigate the thrips which was reported to be causing serious damage to cacao in that colony. Certain estates were also reported to be seriously affected by thrips in November and December 1903, some of which I visited in May 1904.

As the result of these reported attacks, and the consequent investigation by the officers of the Imperial Department of Agriculture, the situation seems to be as follows: -

Thrips is a pest of cacao, but the amount of damage that it may be able to do is not fully established. Spraying with rosin wash or other contact insecticide will serve to keep the insect in check, but there is still some doubt as to whether the amount of damage from this pest is sufficient to warrant the expense of a general campaign against it.

The insects known as thrips are members of the Thysanoptera, one of the primitive orders of insects. The cacao thrips is small, the adult being about $\frac{1}{10}$ inch in length. Seen with the naked eye, the adult appears as a dark-coloured, narrow insect, very pointed behind: the legs and wings being hardly distinguishable. The younger stages are lighter in colour; that next the adult being a pale yellow with a bright-red transverse band across the base of the abdomen. The next younger stage is of a pale-greenish colour without the red cross-band. No observations seem to have been made as to the place where the eggs are laid, but the cacao thrips is probably similar in habit to closely related forms, which deposit the eggs singly under the surface of the food plants.

The young thrips are active, and may be seen running about, usually with a large drop of dark-coloured fluid attached to the tip of the abdomen, which is deposited from time to time on the leaves, pods, and branches. The adults have small delicate wings fringed with fine hairs, by means of which they fly actively. Both young and adult thrips feed by sucking up their food from a puncture or slit made in the surface of the food substance by the large piercing mandible.

The damage to the cacao plant from the presence of thrips results from the loss of sap and from the numerous small incisions in the leaves, buds, pods, and tender branches. But perhaps the greatest loss to the cacao grower results from the staining occassioned by the dark-coloured excrementitious fluid already mentioned, and the discoloration which follows the puncturing of the pod.

The immense numbers of fine punctures all over the surface of the pod, cause it, while still unripe, to take on almost the same colour as a ripe pod, and the labourers have difficulty in distinguishing between the ripe and the unripe.

The discoloration of the cacao pod caused by the thrips is in the skin of the pod, but by scraping away a bit of the skin the labourer should be able to distinguish between ripe pods and those unripe ones that have coloured up from the attacks of thrips.

Remedies.—As already stated in this paper, the use of any of the contact insecticides as a spray would probably keep the cacao thrips in check and the trials of spraying in Grenada in 1900 and 1901 indicate very beneficial results from that mode of treatment. Thrips, however, is a difficult pest to deal with because of its habits of depositing the eggs inside the tissue of the plant, and because, also, the adult insects have the power of flight. The eggs and the adults therefore escape, to a large extent, the effects of spraying, and only the young (larvae) are killed. From this it will be seen that spraying must be thoroughly done, and the first application must be followed, as soon as the young are seen again, by a second spraying.

Other plants than the cacao which are liable to attack by the cacao thrips ought to be destroyed if they occur as weeds or useless growths; or they should be given the same treatment as the cacao if they are valuable enough to make it worth while.

The secondary food plants of the cacao thrips are cashew, guava, and Liberian coffee.

OTHER INSECTS.

The cacao beetle and thrips are the insects most frequently reported attacking cacao, but several others have been observed in various places at different times. As their occurrence is not general, nor the damage done serious, they are merely mentioned.

Aphis is sometimes found in considerable numbers on the very young and tender leaves and shoots, sucking the juice of the plant. It is a plant louse or green fly, of which there are different kinds attacking different plants. Plant lice are preyed upon by several species of lady-birds, and they may be easily controlled by the use of whale oil soap or kerosene emulsion used as a wash or spray.

The root borer of the sugar-cane (*Diaprepes abbreviatus*) has been known in St Lucia to attack the roots of cacao trees. (See *Agricultural News*, Vol. II; p. 264.) The cacao in which this attack occurred was growing on the site of an old sugar estate. No further attacks have been reported, and as only a few trees suffered at that time, the root borer cannot yet be regarded as a serious pest to cacao. The account of the root borer of the cane on pp. 40-1 of this number of the *West Indian Bulletin* will serve to indicate the lines on which treatment may be applied if the root borer appears in any cacao plantation,

In August 1903 specimens were received from St. Lucia and St. Vincent of a small, brown beetle which was reported to be attacking the leaves of young cacao plants. The beetles were

found in the early morning clinging to the plant, having apparently been feeding during the night.

It was suggested that Paris green and lime might be dusted on the plants to kill the beetles, and hand-picking was also suggested. The attack, however, was of short duration, and as no later attack has been reported, it is not possible to say what success attended the tiial of these methods.

THE FRUIT INDUSTRY AT BARBADOS.

BY J. R. BOVELL, F.L.S., F.C.S.,

Agricultural Superintendent, Barbados.

Within the last three years an effort has been made to establish a fruit industry between Barbados and the United Kingdom, and it is my intention to-day to give a short account of how this industry was started, how it has progressed, and what likelihood there is of its being successfully established.

BANANAS.

As up to the present time the banana is, of all the fruits grown in Barbados, the one most exported, I propose to deal with it first.

In May 1902 the Local Superintendent of the Royal Mail Steam Packet Company invited the Imperial Commissioner of Agriculture to test a new banana carrier, in which it was proposed to convey bananas from the West Indies to England. The inventor, who had had considerable experience in shipping fruit from the Canary Islands, was anxious to devise a plan whereby West Indian bananas could be taken to England and arrive in as good condition as those from the Canaries.

In order to ascertain whether the new carrier was any improvement on the method adopted by the banana growers in the Canary Islands, a bunch of bananas was at the same time packed in the usual Canary Islands' fashion by wrapping it in cotton wadding, paper, and, in the first case, wood-wool.

Both bunches of bananas arrived in England in fairly good condition, and the following report was communicated to

Captain Owen, who forwarded it to the Imperial Commissioner of Agriculture. The writer stated as follows :—

'The two bunches of bananas which I saw at your office this afternoon, just in from the West Indies, were in excellent condition. From their freshness and good, green colour they might have come merely from the Canaries. The bunch packed in "Canary fashion" had a particularly fine and clean appearance, but I fear the packing will be found rather too hot as a general rule. Owing to a mistake in the way of placing the bunch in the new carrier, this one was slightly less good. But what particularly impressed me was the fact that both bunches are not the usual West Indian kind of banana (the Gros Michel) but are the Chinese or Cavendish banana, which is the variety imported so largely from the Canaries. If the Cavendish banana proves on trial to carry better than the other, an impetus in the West Indian fruit trade should follow, because this is the kind which is preferred in the English market.'

Soon after this report was received, i.e., in the following July, two bunches of Cavendish or dwarf bananas packed like those sent from the Canary Islands were forwarded to Covent Garden. These arrived in good condition and sold for 18*s*. 10*d*. From then on, with the help of Messrs. W. Pink & Sons and the Royal Mail Company (the latter at first taking the bananas freight free) an effort has been made to establish a banana trade between Barbados and England.

At first, either from want of knowledge as to the best time to cut the fruit, or from the fact that it was during the hot season, when subsequent results have shown that bananas are apt to spoil if carried in the ordinary hold, several of the shipments arrived over-ripe. Since then, however, the difficulty has, to a great extent, been overcome, and in the cool season the bananas almost invariably arrive in good condition. I regret, however, to say that both last year and this year during the summer months a number of bunches reached England rotten, and a large percentage of the remaining ones were over-ripe, the consequence being that in many instances the amount realized for the fruit hardly paid the freight and expenses.

From July 1902 to December 31 of that year, eighteen bunches of bananas were shipped ; and for the year 1903, 6,691 bunches were shipped. As this was practically the first year in which planters packed the bananas themselves, and as they had had no experience in shipping or packing fruit, the results of the whole year's shipments were looked upon as more or less experimental, and no return was therefore prepared of the average results of each shipment. Since the beginning of this year, however, a careful account has been kept of the results of each shipment. (See tables at end of this paper.)

As will be seen by referring thereto, the average net amount paid to the planters for the bananas shipped from the beginning of January to those by the R.M.S. 'Atrato,' which left here on June 4, was for single bunches 3*s*. 10½*d*., and for bunches packed in double crates 8*s*. 4½*d*.

Since then, however, owing to the hot weather, a number of bunches have arrived in England rotten, and a much larger number over-ripe. The result has been that from then until the end of October the average amount paid to planters for single bunches was 2*s*. 2·4*d*., and for double bunches 1*s*. 10 75*d*.

I am glad, however, to report that, owing to the weather being cooler, the bananas are again arriving in England in fairly good condition and realizing better prices.

In Barbados the bananas are usually planted in rows 10 feet apart and 10 feet apart in the rows; consequently there are 435 clumps to the acre. Assuming that after the first year two bunches only are obtained from each clump per annum, this would be 870 bunches per acre per annum. In the Canary Islands, where the same banana is grown, the yield is from 800 to 1,000 bunches per acre per annum. Let us assume that in Barbados, owing to various causes, including the praedial thief, only 600 bunches are obtained per acre (I may mention that one grower has had from January 1 to the end of November 136 bunches stolen from 2 acres of bananas); if the bananas shipped during the hot months had arrived in England in as good condition as those from the beginning of the year to the middle of June, the average price for the year to date would have been at least 3*s*. per bunch for single bunches and 2*s*. 9*d*. per bunch for those packed in double crates; as the cost of the crate, packing, etc., is, on the average, about 1*s*. 6*d*. per single bunch and 1*s*. 3*d*. per bunch for bunches packed in double crates, the net value to the planter for a single bunch would be 1*s*. 6*d*. per bunch, and for those packed in double crates the same, viz., 1*s*. 6*d*. To be on the safe side, however, I will assume that the planter only received 1*s*. per bunch net; at 600 bunches per acre, this would be £30 per acre per annum.

According to the Hon. W. Fawcett's paper on the banana industry in Jamaica (see *West Indian Bulletin*, Vol. III, p. 166), the cost of bringing a non-irrigated estate on the north side of that island into bearing is £10, and the maintenance £7 10*s*. per acre. This includes carriage to the shipping port. Assuming that the cost in Barbados is £10 per acre per annum, the net profit derived from an acre of bananas would amount to £20 per annum. It will therefore be seen that, if the bananas are carried to England in good condition, there is no crop at present grown in Barbados likely to be as remunerative.

As it may be of interest to those who have had no experience in packing and shipping bananas, I may mention that they are cut about fifteen days before they would be ripe. At this stage the bananas are still slightly angular and of a green colour. If there is any doubt about the right age at which the bananas should be cut, the best way definitely to settle the matter is to take off an individual fruit or finger from the lowest hand of the bunch. Cut this fruit diagonally across, and if there is a faint yellow tinge in the centre of the fruit around the black specks, which are the unfertilized ovules, the bunch is in the right condition for

shipment. If the entire cut surface is white, the bunch is too green, and if the whole of the cut surface is yellow, the fruit is too ripe. The bunch of bananas should also have the small end of the spike cut off leaving not less than 4 inches for the bunch to be hung up by in the fruiterer's shop. This should be done some weeks before the bunch is shipped, as, if it is done at the same time the bunch is cut, the cut end of the spike usually decays to such an extent as to affect the lowest hand of the bunch.

In packing the bananas great care should be taken that the fruits have not even the slightest bruise. Bunches containing fruit that is bruised, however slightly, should not be shipped. Each bunch should first be wrapped in cotton wadding and then in paper. Strings of shag (the sheaf of the banana leaf) should be lightly wrapped around the sheets of paper to keep them in position while the bunch is being put into the crate. Having wrapped the bunch of bananas, put into a crate, on which only half of the slats have been nailed, a sufficient quantity of dried banana leaves (the blades or thin portions of the leaf on each side of the mid-rib) to form a bed about 1 inch thick when pressed by the weight of the bunch. This will protect the under side of the bunch from coming into contact with the crate.

Having placed the bunch in the crate, gradually stuff the dried leaves round it, until sufficient have been put in to prevent the paper from unwrapping. Now cut the shag string and draw it out, and continue the packing until the bunch is firmly fixed in the crate. The remainder of the slats should be nailed on as they are needed to keep the packing in its place.

In Barbados, where a large number of growers ship their bananas through the Imperial Department of Agriculture, great care has to be taken in marking the crates so that no confusion shall arise when they arrive in England. Each estate is assigned a number, and the consignee's initials and the estate's number are stencilled on one end of the crate. On the centre piece of the same end there should be one or more X's stencilled to indicate the quality of the fruit. A bunch weighing, when ready packed in the crate, from 40 lb. to 49 lb. gross, should have X; one weighing from 50 lb. to 59 lb., XX; one weighing from 60 lb. to 69 lb., XXX; one weighing from 70 lb. to 79 lb., XXXX; and so on up to 100 lb. or more. On the side of the crate should be marked the consignee's initials, the estate's number, and the port of consignment.

As the crates are stored on the end in which the stem or thick end of the bunch is placed, it is necessary, for the marks to be clearly seen, that they be stencilled on the end of the crate containing the small end of the bunch.

When a bunch of bananas ready packed will weigh less than 60 lb., two bunches may be packed in one crate side by side: in this case the cross pieces of the end of the crate are made longer and about two or three slats more are required on each side. When two bunches are put in one crate the figure 2 is put after the X's. Thus a crate containing two bunches

which together weighed 75 lb. should be marked on the cross piece XXXX 2. Bunches which will weigh more than 60 lb. when packed should be shipped by themselves: in fact, as a rule, it is found that it is more remunerative to ship in single than in double crates.

In Barbados bananas are grown at present practically all over the island; but it appears probable that, owing to the small size of the bunches in the dry districts, their growth will, to a certain extent, have to be restricted to the parts of the island where the rainfall is about 80 inches per annum, or where it is possible for the land to be irrigated.

MANGOS.

The fruit of which most have been shipped next to bananas is the mango, and I will now deal with this. From June 6, 1903, to the end of October 1904, 17,411 mangos were shipped. Owing to the number that arrived in England in bad condition, only 8,269 were sold, and after paying all expenses they netted the shippers about 1·88c. each. To show what good mangos are likely to fetch at the right season, I might mention that on one occasion Messrs. W. Pink & Sons wrote to tell me that a few of the best mangos packed in fancy baskets and sent to London were sold for 1*s.* 6*d.* each. In some instances the mangos arrived in England in splendid condition, and in others practically the whole consignment rotted. I trust, however, that later on, when we know more about the right temperature at which to carry them, their shipment will be as remunerative as that of bananas.

AVOCADO PEARS.

The next fruit to deal with is the avocado pear. From time to time small lots of avocado pears have been shipped, amounting in the aggregate to eighty-eight, of which I have received account sales for eighty. Of these eighty, sixty-seven arrived in good condition and netted the shippers 12·4c. each.

CITRUS FRUIT.

The quantity of citrus fruit I have shipped as yet is so small that it is hardly worth saying anything about. One shipment consisting of three dozen shaddocks and three dozen grape fruit was made on December 12, 1903. These were sent at the same time as some mangos belonging to the same shipper and the account sale received did not show the amount realized for each kind of fruit. Assuming, however, that the mangos sold on the average for the same as those mentioned above, viz., 1·88c. each, the six dozen shaddocks and grape fruit netted to the shipper 96c.

GOLDEN APPLES.

The only other fruit shipped, of which I have received an account sale, is the golden apple. Fifty-four of these fruits have been shipped; all arrived in good condition and netted to the shipper 15c.

In conclusion I may say, first, that if the bananas grown in Barbados, which are reported to be some of the best sent to the United Kingdom, can only be landed regularly in good condition, there is every likelihood of a successful and very remunerative industry being established—an industry which will give in the suitable districts a net profit of about £20 per acre per annum, a return not likely to be reached by any other crop grown at present in those districts. Secondly, that as soon as the right temperature at which to carry mangos and avocado pears can be ascertained, there is every likelihood of the shipment of these fruits proving, to a limited extent, remunerative. With regard to the shaddocks, grape fruit, and golden apples, the quantity shipped to the present time is so small that I am unable to say whether there is any likelihood of an industry in these fruits being established.

ACCOUNT OF SINGLE BUNCHES OF BANANAS SHIPPED FROM JANUARY 1 TO OCTOBER 31, 1904 (INCLUSIVE).

Date.		Steamer.	Bunches shipped.	Bunches bad.	Bunches paid for per mail.	Amount received for shipment.			Amount per bunch per mail.	
						£	s.	d.	s.	d.
Jan.	2	Tagus ..	123	7	116	20	16	7	3	7
„	16	Atrato	101	3	98	18	7	4	3	8
„	30	Orinoco	72	0	72	13	16	4	3	10
Feb.	13	Trent ..	113	0	113	23	18	2½	4	2¾
„	27	LaPlata	108	3	105	22	17	9¼	4	4
March	12	Tagus ...	100	5	95	22	3	10¼	4	8
„	26	Atrato ..	85	3	82	17	16	4½	4	4
April	9	Orinoco	109	4	105	22	8	7¾	4	3
„	23	Trent .	138	0	138	29	12	2	4	3½
May	7	LaPlata	154	1	153	32	10	5½	4	3
„	21	Tagus ...	299	0	299	50	4	7¼	3	4¼
June	4	Atrato..	308	2	306	50	19	0¾	3	3¾
„	18	Orinoco	356	26	330	50	3	0¾	3	0½
July	2	Trent ...	426	7	419	64	3	9½	3	0¾
„	16	LaPlata	512	19	493	89	2	7¾	3	7¼
„	30	Tagus ...	514	0	514	95	10	3½	3	8½
Aug.	13	Atrato...	565	62	503	65	0	9¾	2	7
„	27	Orinoco	508	49	459	58	15	8¾	2	6½
Sept.	10	Trent ...	710	20	690	49	7	2	1	5
„	24	LaPlata	952	189	763	52	10	4½	1	4½
Oct.	8	Tagus ...	918	60	858	51	0	3¾	1	2¼
„	22	Atrato...	841	80	761	61	8	11	1	7¼
		Total ...	8,012	540	7,472	962	9	6	2	6·9*

* Average amount received per single bunch for one year.

ACCOUNT OF DOUBLE BUNCHES OF BANANAS SHIPPED FROM JANUARY 1 TO OCTOBER 31, 1904 (INCLUSIVE).

Date.	Steamer.	Bunches shipped.	Bunches bad.	Bunches paid for per mail.	Amount received for shipment. £	s.	d.	Amount per bunch per mail. s.	d.
Jan. 2	Tagus ..	22	0	22	3	0	1	2	8
„ 16	Atrato ...	30	0	30	4	3	11	2	9
„ 30	Orinoco ..	22	0	22	4	5	3	3	10
Feb. 13	Trent ..	58	0	58	9	3	6	3	2
„ 27	La Plata..	48	0	48	9	13	4½	4	0
Mar. 12	Tagus ..	58	0	58	10	5	1	3	6
„ 26	Atrato	58	0	58	10	0	0	3	5
April 9	Orinoco ..	82	0	82	14	18	0½	3	7
„ 23	Trent ...	186	2	184	33	8	10	3	7½
May 7	La Plata...	160	2	158	28	0	6½	3	6½
„ 21	Tagus ..	164	0	164	24	11	8½	2	11¾
June 4	Atrato ...	92	0	92	14	0	0½	3	0½
„ 18	Orinoco ...	272	6	266	25	8	3	1	10¾
July 2	Trent ...	234	14	220	20	15	2½	1	11½
„ 16	La Plata...	290	36	254	28	10	5	2	2¾
„ 30	Tagus ...	386	0	386	54	18	6	2	10
Aug. 13	Atrato ...	356	58	298	21	7	4	1	5
„ 27	Orinoco ...	358	32	326	27	2	7½	1	7¾
Sept. 10	Trent ..	282	8	274	24	13	2	1	9½
„ 24	La Plata...	198	46	152	10	0	11½	1	3¾
Oct. 8	Tagus ...	156	8	148	12	17	7	1	8¾
„ 22	Atrato ..	144	4	140	9	18	0½	1	4¾
	Total ..	3,656	216	3,440	401	2	5½	2	3·9*

* Average amount received per double bunch for year.

DISCUSSION.

The Hon. F. M. ALLEYNE (Barbados): I should like to corroborate all that Mr. Bovell has said except as to the time when bananas should be picked. He says they should be picked at least fifteen days before they are due to arrive in England. I think he rather understates it. On the estates with which I am connected, bananas are picked so as to allow of twenty-one days before arrival in England. We began to ship in April last year (1904), and when we left off we had shipped 583 bunches, and after paying all expenses we netted 1*s.* 2*d.* per bunch. Many shipments, however, have been unsuccessful, that is to say, the fruit did not arrive in good condition. But we hope that the Royal Mail Co. will provide sufficient cool storage, and when that is done I have no doubt that the profit will be increased. I think the effort has been remunerative and I do not propose to stop it. But I am sorry to say many planters are so dissatisfied with their returns that they either discontinue exporting bananas altogether, or diminish the output.* I remember once shipping a single crate with two small bunches of claret-coloured bananas which fetched 21*s.* at Portsmouth.

The PRESIDENT: Barbados is the last port of call of the Royal Mail steamers, and that gives her an advantage over other colonies in the shipment of fruit. The bananas there are shipped in crates; it is a costly arrangement, but it has proved successful, and it is proposed to continue it. The industry was progressing until July last year when, on account of the hot weather and the enormous fruit crop in England, prices fell, and many of the planters for a time lost money. On the whole, the experiment has been a success. Our chief trouble is in securing exactly the right conditions on board ship. We have asked the Royal Mail Co. to fit all their ships with cool chambers and thus keep the fruit at a uniform temperature (say, between 60° and 65° F.). The 'Tagus' and the 'Trent' are the only two ships at present that are fitted with cool chambers. We have established the fact that if we ship well-selected fruit in cool chambers there is no doubt of its arriving in England in good order. The Royal Mail Co. has given considerable attention to the proposals offered to it, and has shown its willingness to carry them out; until, however, all the ships are furnished with cool chambers we shall still be left without the necessary accommodation during the hot months.

Dr. VAN HALL (Dutch Guiana): We have made trial shipments of bananas from Surinam on a small scale, but there is this drawback: there is, so far, no special banana cultivation and consequently the bunches produced are not full-sized bunches. I would like to know if that is a drawback which also exists at Barbados.

The Hon. F. M. ALLEYNE: We are distinctly advised not to ship small bunches, that is, less than seven hands. Small bunches are consumed locally.

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* These were only temporary measures. Since the date of the Conference the export of bananas from Barbados has been steadily increasing. [Ed. *W.I.B.*]

Dr. VAN HALL: What sort of bananas would be the best for shipment? It would take twenty-three days for our fruit to reach Amsterdam, and one of the species we have, very closely resembling the Gros Michel, has always arrived in good condition.

The PRESIDENT: The banana shipped from the Canary Isles, and also from Barbados, is the Chinese or dwarf banana (*Musa Cavendishii*).

Dr. H. A. ALFORD NICHOLLS (Dominica): I have had tables prepared showing the fruit exports of Dominica. As these may be of interest I will hand them in for publication.

SHIPMENTS OF FRUITS AND VEGETABLES FROM DOMINICA.

Year.	Bananas, bunches.	Oranges.	Cocoa-nuts.	Other kinds and vegetables. Value.
				£
1899	2,681	1,407,175	186,703	220
1900	8,619	1,557,080	189,261	211
1901	7,425	673,920	259,200	198
1902	7,006	772,200	239,714	240
1903	9,324	704,520	307,691	281
1904	5,050	738,360	207,050	320

LIME SHIPMENTS.

Total shipments converted into barrels of fruit, on the bases of a concentration of eleven to one, and of 8 gallons of juice per barrel of fruit:—

1895	78,182 barrels.	1901	147,706 barrels	
1896	88,624 „	1902	220,740 „	
1897	90,837 „	1903	107,883 „	(Blight and gale.)
1898	125,816 „			
1899	127,556 „	1904	153,523 „	
1900	164,806 „			

SHIPMENTS OF ESSENTIAL OIL OF LIMES.

1904. Gals.		1899. Gals.	1900. Gals.	1901. Gals.	1902. Gals.	1903. Gals.
2,261	Distilled oil of limes	3,815	3,990	3,299	4,761	2,740
543	Otto of limes	272	456	608	948	310

RESULTS OF EXPERIMENTS IN THE CULTIVATION OF COTTON IN THE WEST INDIES.

BARBADOS.

Mr. J. R. BOVELL (Barbados): As so much has already appeared in the publications of the Imperial Department of Agriculture for the West Indies on the preparation of the land for cotton, the manuring of the land, the picking of seed-cotton, etc., there is no need for me to say anything on these points. There are, however, one or two subjects which have not been dealt with from a West Indian point of view. One is the time to plant cotton, and the other—to which all the others are, so to speak, subservient—the monetary profit to be derived from the cultivation of cotton.

With regard to the date of planting, it is impossible yet, with our short experience, to say definitely which is the month for planting cotton in Barbados, but from the experience already gained it would appear that the best time is between the beginning of June and the end of September. In the drier districts it would perhaps be better to plant earlier in the season, and in the higher districts, where there is a greater rainfall, later.

With regard to the profit derived from an acre, this is, I know, given in the publications referred to above for the plantations in the Sea Islands, but as the conditions that prevail there are different from those which obtain in the West Indies, it may not be without interest if I give the results obtained in Barbados last season on certain typical estates.

As I knew that certain of the cotton growers had kept accurate accounts of the cost of growing their cotton, and of the revenue obtained, I asked ten of these gentlemen to supply me with the information, and it is given in detail in Table I of this paper. Summarized, it is as follows:—

Area under cotton cultivation...	95·25 acres.
Maximum quantity for one grower	34·00 „
Minimum „ „ „ „	·75 „
Average weight of lint obtained per acre	235 lb.
Maximum „ „ „ „ „ „	300 „
Minimum „ „ „ „ „ „	161 „
Average quantity of seed obtained per acre	558 „
Maximum „ „ „ „ „ „	756 „
Minimum „ „ „ „ „ „	388 „
Average total revenue per acre for lint and seed (the seed valued at 1¼c. per lb., the price at which it is sold in Barbados for stock feed) ...	$70·59—(£14 14s. 1½d.)
Average amount realized for cotton per acre	$63·53—(£13 4s. 11d.)
Maximum amount realized for cotton per acre	$84·00—(£17 10s. 0d.)

Minimum amount realized for cotton per acre	\$45·61—(£ 9 10s. 0½d.)
Average cost of growing cotton, including manure on certain of the estates, but excluding cost of supervision, taxes, and interest on capital ...	\$20·50—(£ 4 5s. 9½d.)
Maximum cost of growing cotton, etc. ...	\$28·39—(£ 5 18s. 3½d.)
Minimum „ „ „ „ „ ...	\$10 45—(£ 2 8s. 6½d.)
Average profit per acre	\$50·00—(£10 8s. 4 d.)
Maximum „ „ „	\$77·30—(£16 2s. 1 d.)
Minimum „ „ „	\$35·89—(£ 7 9s. 6½d.)

From the above it will be seen that the cost of growing cotton in Barbados compares very favourably with that of the Sea Islands. The average returns there on fourteen representative estates in the counties of Beaufort, Berkley, and Charleston in South Carolina for 1896 are given in the *West Indian Bulletin*, Vol. IV, p. 314, from which it will be seen that the total cost of production per acre was \$35·40 (£7 7s. 6d.) and the profit \$23·47 (£4 17s. 9½d.). In this case the average yield of lint per acre was 204 ℔. and seed 14·3 bushels, equal, at 42 ℔. to the bushel, to 600 ℔. per acre.

Assuming that the cost of supervision, watchman's wages, taxes, and other expenses incidental to the production of cotton, the carriage, etc., to be \$4·78 (19s. 11d.) per acre, the amount which it actually cost one of the growers who kept a careful account of the cost of producing his cotton, the average net profit per acre for 95¼ acres is \$45·22 (£9 8s. 5d.).

As the average yield was 235 ℔. per acre, the cost of growing the cotton, ginning, and shipping, etc., including supervision, taxes, etc., was 12·3c. per ℔., – excluding supervision, etc., 10·3c. per ℔.

As the grower's statement just referred to is of much interest, I have given it *in extenso* in Table III.

TABLE I.

Results obtained from $95\frac{1}{4}$ Acres of Cotton grown on Ten Estates in Barbados for the year 1904.

Name of Estate.	Area.	Pounds of cotton lint shipped.	Net amount realized for lint. $	c.	Pounds of cotton seed.	Value of cotton seed. $	c.	Total Revenue. $	c.	Cost of growing cotton. $	c.	Net amount received. $	c.
A. ...	12 acres	2,643	724	72	5,968	74	48	799	20	226	75	572	45
B. ...	11 „	2,456	600	56	5,856	73	20	673	76	114	95	558	81
C. ...	34 „	9,234	2,472	53	21,355	266	94	2,739	47	965	23	1,774	24
D. ...	$5\frac{3}{4}$ „	970	290	10	2,234	27	92	318	02	111	66	206	36
E. ...	$15\frac{1}{2}$ „	2,493	706	93	7,017	87	71	794	64	205	40	589	24
F. ...	$\frac{3}{4}$ „	160	46	42	430	5	37	51	79	14	75	37	04
G. ...	3 „	840	245	28	2,146	26	82	272	10	47	00	225	10
H. ...	$1\frac{1}{4}$ „	320	92	80	908	11	35	104	15	34	22	69	93
I. ..	3 „	900	252	00	2,272	28	40	280	40	48	49	231	91
J. ...	9 „	2,373	623	87	5,273	65	91	689	78	193	00	496	78
Totals...	$95\frac{1}{4}$ acres	22,389	6,055	21	53,459	668	10	6,723	31	1,961	45	4,761	86
Average per Acre.		235·05	63	58	553·4	7	01	70	59	20	59	50	00

TABLE II.

AVERAGE YIELD, NET AMOUNT REALIZED, COST OF GROWING AN ACRE OF COTTON ON TEN ESTATES IN BARBADOS.

Name of Estate.	Area.	Pounds of cotton lint shipped per acre.	Net amount realized for lint per acre. $ c.	Pounds of cotton seed per acre.	Value of cotton seed per acre. $ c.	Total revenue. per acre. $ c.	Cost of growing cotton per acre. $ c.	Net amount received. per acre. $ c.
A. ..	12 acres.	220¼	60 39	497	6 21	66 60	18 90	47 70
B. ...	11 ,,	223	54 60	532	6 65	61 25	10 45	50 80
C. ...	34 ,,	272	72 72	628	7 85	80 57	28 30	52 18
D. ...	5¾ ,,	169	50 45	388	4 85	55 31	19 42	35 89
E. ...	15½ ,,	161	45 61	453	5 66	51 27	13 25	38 02
F. ..	¾ ,,	213⅓	61 89	573	7 16	69 05	19 66	49 38
G. ..	3 ,,	280	81 76	715	8 94	90 70	15 67	75 03
H. ...	1¼ ,,	256	74 24	726	9 08	83 32	27 38	55 94
I. ...	3 ,,	300	84 00	757	9 47	93 47	16 16	77 30
J. ...	9 ,,	263⅔	69 32	586	7 32	76 64	21 44	55 20

TABLE III.

At..... ......Plantation in...... ... Parish, a 3-acre field of Sea Island cotton was planted August 18, 1903. The first picking was made the first week in January, 1904, and the last picking in May 1904.

Total quantity of seed-cotton obtained	2,860 lb.	
Total quantity of pure lint obtained	840 lb. at 33c. per lb. ...	$227·20

EXPENSES.

A crop of Bengal beans was grown and turned under as a green manuring at a cost of ...$	1·66	
All cultivation, including forking, hoeing, levelling the surface, and weeding ...	12·93	
Chopping for sowing and supplying cotton at 30c. per acre	·90	
Cost of seed, 5 lb. per acre, 15 lb. at 7c. per lb.	1·05	
Cost of special cotton seed manure given ...	5·00	
Carting and applying of same	·21	
Singling and moulding up cotton twice at 60c. per acre	1·80	
Picking and cleaning cotton at 80c. per 100 lb. gross	22 95	
Bagging, sewing up, marking for delivery ...	·30	
Carting same to the factory at 10c. per 1,000 lb.	·20	
Directing, supervising, superintending, and watching at ½c. per lb. gross of seed-cotton	14·34	
All taxes at $1·00 per acre, or about ⅓c. per 100 lb. of lint	3·00	
Factory expenses, ginning and baling at 2c. per lb. of lint	16·80	
Freight to England and other expenses of sale, cartage, marine insurance, lighterage, and 1½ per cent. discount at 1·8c. per lb. of lint...	15·12	96·26
Net profit on 3 acres		$180·94
Net profit per acre		$60·31

LEEWARD ISLANDS.

Dr. Francis Watts (Leeward Islands): Experiments in the Leeward Islands were begun simultaneously by the Department of Agriculture and Messrs. Sendall and Wade, of St. Kitt's. The Experiment Stations in the neighbouring island had small plots which produced useful results in that at an early stage they enabled us to discriminate between the different cottons. It was obvious from these early experiments that Sea Island was the variety to which we should direct our attention, and subsequent experiments have confirmed this. In 1902, Messrs. Sendall and Wade erected a steam ginnery on one of their

properties, following this, in 1903, by the erection of a steam ginnery in Montserrat, while the Department of Agriculture provided a hand gin for the conduct of small Botanic Station experiments. In the following year, 1904, aided by the British Cotton-growing Association, the Department of Agriculture established a ginnery in Antigua, and Mr. E. Y. Connell, with some assistance from the British Cotton-growing Association, established a steam ginnery in Nevis. In Montserrat, in addition to Messrs. Sendall and Wade's ginnery, another, assisted by the British Cotton-growing Association, was started by Mrs. Howes and Mr. Wilkin. As to the progress of the industry, at first it was taken up largely by Messrs. Sendall and Wade in St. Kitt's; their enterprise soon extending to Montserrat, where several other people also embarked in cotton growing; then in Antigua a number of people put in small experiments, which, in the aggregate, amounted in 1903 to 400 or 500 acres. The present position of the industry in the several islands indicates the progress that has been made. In St. Kitt's there are about 1,100 acres under cultivation; in Nevis, over 1,000 acres; in the small dependency of Anguilla, 250 acres; in Antigua, 400 to 500 acres; Montserrat, 500 to 600 acres. In each of these islands, except perhaps Antigua, there has been substantial progress in the number of acres planted, and equally substantial progress in the methods adopted. The smaller area under cultivation in Antigua this year than the last does not correctly represent the situation, because I believe it will produce a larger quantity of cotton than was produced by the larger area in the previous year. But in no island has the progress been equal to that in Nevis, where over 1,000 acres are planted, and I may say that that has been largely the result of internal effort. I say this because the conditions there are somewhat different from the conditions in St. Vincent where the large areas are the direct result of governmental effort. The rapid development of the industry in Nevis is the result of personal effort on the part of the people of the place. The Department of Agriculture has been able to play an important part in directing these efforts and in keeping them on right lines; also in procuring seed and generally in supplying that information and help which enabled true energetic local efforts to become rapidly successful, while the assistance of the British Cotton-growing Association, in helping to provide maintenance, was invaluable. I regard the industry in Nevis as particularly well established, in that the people have sought and enlisted the assistance of the Department of Agriculture in a right manner, and have themselves developed their industry by an admirable internal effort. In St. Kitt's the land is prepared as for cane and the bulk of the cotton is planted on the banks prior to the planting of the canes, in anticipation of the cotton crop being reaped and out of the way before the canes arrive at any appreciable size. It is hoped that the cotton will not interfere with the canes, or in any way render the cane crop smaller. It is premature yet to say what the results will be. I think if there is a fair amount of rain after the cotton crop has been reaped, the results will be good, and that this method of working will pay. If

that is so, then the sugar planters of St. Kitt's will go in largely for sugar and cotton, and cotton combined with sugar will assume a great deal of importance. If, on the other hand, it is found that the cotton crop grown in that way is disastrous to the cane, then cotton will cease to possess much interest. I think, however, the sugar planter will be content to suffer some small diminution of his cane crop, if it can be shown that this is more than compensated by the profits on cotton. If the gain is not appreciable, it is not likely that cotton will make great progress in St. Kitt's. The prospects are hopeful and one looks forward to an increase in the prosperity of St. Kitt's from this combination of sugar and cotton. The one great point of importance in the Leeward Islands will be the question of disease. At first there was a good deal of complaint about caterpillars, but with the introduction of Paris green the caterpillars have no terrors for cotton growers. The leaf-blister mite makes its appearance in all the islands, but can be controlled by the use of sulphur and lime. There are, however, far more insidious enemies in the form of fungoid diseases. These are causing injuries in some places; it is necessary that they be carefully studied so that they may be controlled before they assume serious importance, and to this the Department of Agriculture will direct unremitting attention.

ST. VINCENT.

Mr. W. N. SANDS (St. Vincent): The colony of St. Vincent has produced cotton for a number of years, chiefly at Union, and one or two other small islands of the Grenadines, but this cotton was all of the type known as Marie Galante, a degenerate form of Sea Island or rather a form approaching the original type of Sea Island cotton before being specially selected in the Sea Islands. No true Sea Island cotton, as now known, was grown until the year 1903, when, owing to the great and increasing demand for cotton, and the shortage in England, the Imperial Department of Agriculture was successful in advocating its growth at St. Vincent, and one of the Grenadines, namely, Bequia. During that year (1903) about 300 acres of cotton were planted in different parts of the colony, a good portion being Sea Island. Besides that put in by planters, the Department laid out and planted under the direction of its officers, eleven experiment plots, nine in different districts of St. Vincent, and two at Bequia. In all, 41 acres were put under experimental cultivation. Of this number 21 acres were planted in the Sea Island variety, and the remainder in Upland. These plots served as good object-lessons to intending planters for one season. Taken as a whole, the results obtained from the Sea Island cotton were much better in every way than those obtained from the Upland. With regard to the larger acreage planted by private growers, heavy rains in some cases did considerable damage, and caused the loss of several acres of young cotton. In many instances the land selected was poor, and not sufficient attention was given to cultivation. As with the experiment plots abovementioned, the mistakes served a good purpose, and this season much better land, on the whole,

has been planted up with cotton, and greater care has been paid to its cultivation. During the time the cotton was growing a cotton factory was erected, under the direction of the Imperial Department of Agriculture, at French's, quite close to Kingstown. This factory cost upwards of £2,000 to build, and is the most complete structure of its kind in the West Indies. The plans were designed by Sir Daniel Morris after a visit to the Sea Island cotton districts of the Southern United States. The factory is a three-storied building, the top story being used as the store for seed-cotton as received. On the second floor the gins and baling press are situated. Six Macarthy Roller Sea Island cotton gins are worked, and these, with the labour-saving devices employed, are capable of ginning from 3,600 to 4,000 ℔. of clean lint per working day of nine hours. The record day's work last season was 4,008 ℔. of lint, which shows how well the factory is arranged. The engine and driving machinery are contained on the bottom floor, which is also the store for the bales as completed and the seed as received from the gin. As a result of the first season's experiments, 42,394 ℔. of lint were ginned at the factory, and this amount was made up into 141 bales, each averaging 306 ℔. weight. This amount represents the total crop, except 5 small bales weighing altogether 833 ℔., which were dealt with privately. All the bales were shipped to the British Cotton-growing Association on behalf of growers by the local Government. The prices realized for well-prepared Sea Island cotton were from 14*d.* to 15½*d.* per ℔.; for the Upland and other short-staple cottons from 5*d.* to 8*d.* The results of last season being of an encouraging nature, upwards of 1,500 acres, all Sea Island, have been planted this season: the seed used, with the exception of one small area, was selected Sea Island seed obtained by the Imperial Commissioner of Agriculture from James Island, S.C. The fine samples of this season's (1905) crop submitted to the Conference were from Mr. C. J. Simmons' estates, Villa, Peter's Hope, Cane Grove, and Concord, and Mr. Fraser's estate, Rutland Vale.

Mr. Edwin Richards submitted excellent samples of Sea Island cotton from Grande Sable, Calder, and Mustique.

DISCUSSION.

The Hon. F. M. ALLEYNE (Barbados): I have a rather remarkable return here from Mr. Browne at Kirton estate in Barbados. He planted 22 acres in cotton last year and got a yield of 6,925 ℔. of lint, netting $1,957·21. In addition to that he had 162 ℔. which he did not sell at the time, and estimating that at 28c. per ℔., it made $45·30. Then he had 17,738 ℔. of cotton seed crushed, which, at 1½*d.* per 100 ℔., gave $266·07. He planted through the cotton field a certain amount of Indian corn from which he got 254 bushels, which, at 80c. per bushel, came to $203·20; so that the total gross proceeds of the 22 acres, including the Indian corn, were $2,471·84. Deducting from that a total expenditure of $521·94, it left him a net profit of $1,949·90 or £406 4*s.* 7*d.*

The Hon. S. HENDERSON (Trinidad): What was the cost of weeding?

The Hon. F. M. ALLEYNE: The total cost was $16·50.

The PRESIDENT: There are several samples of cotton in the room, four, I believe, brought by Mr. Bovell from Barbados, samples from St. Vincent, and Mr. Hart has two samples, one from the River estate, and the other from St. Clair Station; another sample is brought by Mr. J. St. Hill. I think it would be well for members of the Conference to make an examination of these samples, as they may be able to have some idea as to the different qualities. Those who came in contact with Mr. Oliver during his visit to the West Indies will appreciate what is meant by an examination of cotton: it involves the length of staple, strength of staple, and, perhaps what is the most important point of all, colour and glossiness. Then follow the question of whether the cotton is harsh, whether there is a natural twist in the fibre, that is, convoluted and resembling a corkscrew.

FUNGOID DISEASES OF COTTON.

BY L. LEWTON-BRAIN, B.A., F.L.S.,

Mycologist on the staff of the Imperial Department of Agriculture.

LEAF DISEASES.

There are three chief leaf diseases of cotton in the West Indies, none of which can be described as serious at present, though with unfavourable conditions they might easily become so.

Rust.—The true leaf rust due to *Uredo gossypii* is fairly common in these islands, although it does not occur in the United States. It was first noticed in South America, and attacks both wild and cultivated cotton. It produces numerous small, brown spots on the leaves. Later, it breaks through the epidermis forming clusters of uredospores. These are of the ordinary type of uredospore borne singly on short hyphae which occur in clusters.

I have not seen the disease attacking healthy plants to any extent; on these it only occurs on older leaves which have lost their vigour. On small stunted plants growing on poor soil, frequently every leaf is badly attacked. In such a case the yield of lint will be reduced.

Leaf-spot.—Another leaf disease, not so common as the rust, is the leaf-spot caused by *Cercospora gossypina.* In this case the spots are more or less circular and sharply defined; the centres are colourless or light, while the margins are very dark-brown

or black. The fructifications are produced in the central part of the spots. The conidia are long, curved, and multicellular. There is another form of fructification belonging to this fungus, the ascus fruit of a *Sphaerella*, but I have not yet met with this in the West Indies. The disease is not of great practical importance in these islands.

Leaf Mildew.—The most common leaf disease in the West Indies is the mildew. The fungus causing it has not yet been identified and in all probability has never been described. I am sending away more specimens and hope to get it described or identified later. The disease occurs on both native and cultivated cotton.

Leaves attacked by the fungus turn yellow or red in irregular areas, frequently at first bounded by the large leaf veins. Finally, the whole leaf is affected, turns yellow and drops off. The under sides of diseased leaves are covered with a white, shining mildew, there is also an internal mycelium in the tissues of the leaf consisting of the mycelium conidiophores and of the fungus conidia: the mycelium is branched closely and septate. The conidia are unicellular, large, and oblong with rounded corners; they are borne singly on short conidiophores.

So far, the disease has only appeared on old leaves which have passed their prime, in which case it simply hastens the fall. One large grower says he considers it to be of use in hastening the fall of old leaves, so admitting light and air to the lower bolls. In Montserrat last year it was said to be more serious.

BOLL DISEASES.

The diseases of the boll are more serious than those of the leaf, especially to the producer, for although the injury to the plant may be slight, the quality of the cotton may be very injuriously affected.

Anthracnose.—I have already published in the *West Indian Bulletin* (Vol. V, pp. 178-94) a fairly full account of one boll disease, the anthracnose. I showed there that the disease is caused by a fungus closely related to, if not identical with, *Colletotrichum gossypii*, the fungus causing anthracnose in the United States.

The fungus causes sunken, dark spots in the walls of the capsule. These, later on, enlarge until the boll becomes deformed. The cotton lint may be invaded by the hyphae of the fungus if the boll is attacked while young, in which case the lint is discoloured. Otherwise the damage done is in the premature ripening and partial opening of the boll, and the difficulty of picking the cotton. The lint soon becomes stained under these conditions, and, besides this, is of a poor quality.

The spores of the fungus are produced abundantly in the centres of the spots, especially in wet weather; fresh crops are produced wherever the conditions are favourable. It is by these spores that the fungus spreads from one boll to another. One of the most striking characters of the fungus is the vitality of its mycelium, which survives dessication for long periods.

The fungus also attacks the cotyledons of cotton and destroys them. It may also attack old mature leaves and may gain a lodgement on leaf scars and wounds.

The most important point in dealing with anthracnose is to destroy, as soon as possible, diseased bolls. These can be burnt, or mixed with lime and buried in a cane field. If they are left lying on the ground in a cotton field, the mycelium in them will produce crop after crop of spores, and so become a constant source of infection for other bolls.

Another point is to admit as much light and air between the plants as is consistent with economy. If the plants are too close, the lower bolls will be shut up in a dark, moist chamber, which gives the fungus the most favourable conditions for its growth and reproduction.

Last year, anthracnose was fairly common in Barbados, but this season, with drier weather, and more expert cultivation, it is far less abundant.

Black Boll.—A disease which has caused great alarm in Montserrat is the so-called 'black boll.' There seems, however, to be some looseness about the way this name is applied, and any bolls which do not develop properly are said to be attacked by this disease. The true 'black boll' appears to be characterized by decay of the internal parts of the boll usually starting at the base, while the outside is apparently healthy. The seeds swell up inside during the later stages (probably a kind of premature germination) and all the lint is destroyed.

According to accounts the disease appears on all kinds of soils and under all conditions. Bacteria appear to be associated with this disease, though whether they are the true cause, or whether the trouble is primarily physiological in origin, I cannot definitely say at present.

Another point to be discovered, which can only be settled by observers who know the conditions and who are always on the spot, is what conditions favour the disease. Does it occur on some soils more than on others? If so, what is the difference? What is the effect of manures, especially nitrogenous ones? Of wet weather? Of close or open planting?

I mentioned the advantages of open planting in connexion with anthracnose. The same damp, moist atmosphere which favours the growth of fungi is specially unsuited to the maturing and ripening of a cotton boll. Whenever plants are growing too close, practically all the lower bolls are lost.

The same reasoning applies to the excessive use of nitrogenous manures. This will be an important point to note in connexion with cotton manurial experiments.

For the present, then, I should advise the avoidance of close planting, highly nitrogenous manures, and heavy, wet, or badly drained soils.

Dropping of Bolls.—It frequently happens that a cotton plant will set more bolls than it is able to mature properly.

In this case, the plant throws off a number of the immature bolls which are found lying about on the soil.

This is not a disease, simply a normal process. It may be brought about by a sudden change of weather, by an attack of the cotton worm or by generally unfavourable conditions.

STEM DISEASES.

A week or two ago I noticed in a field of Seabrook Sea Island cotton a stem disease which may prove of importance. All the plants I could find with the fungus on them were also attacked by the red maggot and until infection experiments have been carried out it cannot be decided whether the fungus by itself is capable of causing the disease.

The leaves were all wilted, while the stem was dark-coloured. In the older cases, parts of the stems were covered with a pink-coloured dust.

Examination showed that this dust was formed by a large number of pustules of spores of a fungus close together. From the characters of the spores the fungus appears to be a species of *Fusarium*, the conidia being sickle-shaped and multicellular. Fungus hyphae were present inside the tissues, especially in the inner part of the wood.

It will be remembered that the wilt disease of cotton is caused by a *Fusarium* I sent specimens to the U.S. Department of Agriculture at Washington to ask if the fungus could be identified, but as yet have had no reply.*

I have obtained pure cultures of the fungus and have started infection experiments. As yet, of course, these have given no results.

A point to be noted is that most of the Sea Island cotton planted this year is of the Rivers' variety which is known to be resistant to wilt disease.

I should like to know whether a similar disease has been noted in the other islands, and, if so, on what cotton. So far, I have only seen it in one field, and then in connexion with the red maggot.

It may, perhaps, be remembered that in Egypt the wilt fungus only attacks cankered stems.

ADDENDUM.

The following is a report dated March 8, 1905, by Mr. L. Lewton-Brain, B.A., F.L.S., on the 'black boll' disease of cotton at Antigua and Montserrat:—

I have the honour to submit, herewith, a report on my recent visit to Antigua and Montserrat for the purpose of studying the so-called 'black boll' of cotton.

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* A reply has since been received to the effect that in all probability this *Fusarium* had no connexion with the *Fusarium* of wilt. It seems certain that this fungus is, at most, a weak wound parasite.

There is undoubtedly a distinct disease of the bolls differing entirely from anthracnose and physiological drying up, though sometimes confused with these. Probably the first outward sign of the disease is a curious deformation of the boll; in place of being more or less oval it is practically spherical and tapers very suddenly to a sharp point; the boll is also distinctly more resistant to pressure than the normal one. On cutting open such a boll it is usually found that rot has set in, part of the lint being discoloured, while the seeds are larger than the normal. The decay may start at any point inside the boll, not necessarily at or near the base. As the disease advances more of the lint rots, becoming slimy and changing colour from yellow to dark-brown or black. Finally the enlarged, partially germinated seeds practically fill the interior of the boll, being separated only by a thin film of decayed lint. Up to this time there is no sign of unhealthiness outside the boll. Most commonly the diseased bolls, about the time they should be opening, drop off the plants. I saw several fields which had lost every boll in this way. Very commonly this is the first sign noticed of the disease. Sometimes, however, the bolls dry up on the plant and open slightly; they can, however, from the appearance of the lint, be easily distinguished from bolls dried up through drought.

The disease is not due to climatic conditions, as it has occurred both in the present very dry season in Antigua and Montserrat, and in the last season at Montserrat which was extremely wet..

The soil again is not the cause of the disease, it occurs in both the limestone and clay soils of Antigua as well as in Montserrat. It also occurs both on poor and on rich land.

I was unable to connect the disease with any insect attack. It also is not a result of any other plant disease: frequently one or two bolls on a plant may be attacked while others on the same plant are quite healthy: also plants which have lost every boll afterwards bear a second crop, many of which are perfectly sound; again, I made a careful microscopic examination of stems, etc., of plants with diseased bolls, without finding a trace of fungus hyphae or bacteria. So far as leaf diseases go, badly attacked fields are frequently more healthy than others suffering far less severely.

The only foreign organism present in diseased bolls is a short, rod-shaped, non-motile bacillus, and this is constantly present in diseased tissues. Until inoculation experiments have definitely settled the point, this bacillus is to be regarded as the primary cause of 'black boll.'

It is extremely difficult to arrive at any conclusions as to conditions which favour the spread of the disease. Climatic conditions appear to have very little effect. I was unable to notice any difference between any of the manurial experiment plots. The amount of leaf disease has no connexion with that of black boll. The composition of the soil (clay or limestone) also appears to have no influence. In many cases, where in the same locality, some plants were badly affected and others less so, the badly affected plants were those growing

in rich or heavily manured soils and were rank and luxuriant in growth, while the plants growing on the poorer soil were smaller, and were not so badly affected. This rule, however, does not apply throughout, as there were fields badly affected on fair soil where the plants were small and not too luxuriant in their vegetative growth. Also, I saw cases of two adjacent fields, absolutely identical in soil, drainage, situation, and in the growth of the plants, where the cotton in one field had lost every boll through this disease, while that in the other had been only slightly affected and was giving a good return of lint.

The chief points that remain to be determined are the manner and time of infection. It seems probable that infection takes place at the flowering stage through the agency either of wind or insects. It is quite possible that it may take place later, when the bolls are set. I attach a memorandum setting forward some experiments that might be carried out at Antigua, and which should help to clear up this matter. It is too late in the season for them to be carried out on a sufficiently large scale now, but they should be taken in hand as early as possible next season. In view of the fact that 'black boll' is the most serious disease of cotton we have to deal with in the West Indies, I would also suggest that the Mycologist should spend some time at Antigua next December in order to carry out artificial inoculation experiments with pure cultures of the bacilli.

It is difficult to make any recommendations with regard to treatment of 'black boll.' I should advise that cotton be not planted on very rich virgin soil, but that in such cases corn or some similar exhausting crop be planted first, I would also deprecate excessive use of manures especially nitrogenous ones. I would not advise the immediate destruction of even badly attacked plants as they frequently give a fair yield as second crop; the plants may either be allowed to grow from the upper branches or be cut back according to circumstances; when the bolls are drying up on the plant, cutting back would be better and the diseased material should be destroyed. The destruction of the plant remains after picking is finished should of course be carefully carried out. Fields that have been badly attacked this year should not be replanted in cotton.

The best hope of dealing thoroughly with the disease is by way of raising a resistant variety. That this is possible is shown by the fact that the native cotton is apparently quite immune to 'black boll.' A beginning might be made next season in Antigua and Montserrat by selecting healthy plants (not bolls) in badly attacked fields and carefully setting apart the seed for further experiment the following season.

In conclusion I should say that this year's experience shows that 'black boll' can exist in fields without destroying any large proportion of the bolls. If care be taken to plant only suitable land in cotton and to cultivate it properly, at most only an occasional bad attack is to be apprehended.

Memorandum with regard to suggested field experiments in connexion with 'black boll' of Cotton.

A. Fifty flower buds to be enclosed in muslin bags as if for cross-pollination purposes. The flowers to be artificially pollinated when necessary and again enclosed till bolls are ripe.

B. Fifty flowers to be similarly bagged after the bolls have set and until ripeness.

C. (Control) Fifty bolls to be marked but not enclosed.

If neither A. nor B. is attacked, it will prove that infection takes place through the agency of insects and after the bolls are set.

If B. is attacked and not A., it will prove that infection takes place through the agency of insects and during the flowering stage.

If A., B , and C. are equally affected, it will show that infection is effected by wind.

The following experiments are intended to show whether the diseased bolls are a source of infection :—

D. As A., but a dry, diseased boll to be enclosed in the muslin bag.

E. As B., but with diseased boll as in D.

THE INSECT PESTS OF COTTON.

BY HENRY A. BALLOU, B.Sc.,

Entomologist on the staff of the Imperial Department of Agriculture.

The rapid increase in acreage of any crop is almost certain to be accompanied by the rapid increase of those insects which prey upon it and find it a suitable substitute for some wild plant which formerly served as a food supply. Cotton has proved no exception to this general rule, and, at the present time, several pests of cotton are known which had previously not attracted attention from their attacks either on other crops and wild plants or on the scattered plants of cotton growing uncultivated in the several islands.

THE COTTON WORM.

(*Aletia argillacea.*)

This insect is a native of South America and the West Indies. It was first named and described in 1822 from specimens from Bahia, but historical writings contain reference to its occurrence in Tropical America for many years previous to that time. It occurs in every island in the British West Indies where cotton is now growing on a large scale with the single exception of St. Vincent.

In most of these places the cotton worm has occurred as a serious pest during the past three years, in some cases causing

serious damage to the crop and, in a few instances, its entire destruction.

Cotton growers are familiar with the appearance of the cotton worm, which has been described at length in the *West Indian Bulletin* (Vol. IV, pp. 268 and 326-34).

The adult is a small, olive-grey moth, which hides during the day and flies about at night or in the dusk of evening. The eggs are very small, laid on the under surface of the leaves, singly and not in clusters. From their small size, their greenish colour, and the fact that they are not laid in clusters, they are not often seen. The larva or caterpillar is the 'cotton worm.' When first hatched from the egg, the larva is very small, greenish in colour, and feeds on the under side of the leaf. As it grows older it increases in size, the dark stripe down the back becomes more marked, and it eats at the edge of the leaf. When nearly full-grown the worms eat very fast and the injury to the cotton becomes noticeable all at once. This has led to the belief that the cotton worm destroys a field of cotton in a single night. When fully grown the larva ties over a portion of a leaf, and in the folds thus formed spins a few silken threads to form a very slight cocoon, inside which the pupa is to be formed.

The time required for the life of the cotton worm varies, but the following may be regarded as the average duration of each stage: eggs, four days: larva, sixteen days; pupa; twelve days; adult, ten days.

In combating the cotton worm it is essential that a very sharp lookout be kept for its first appearance, upon which the application of poison should be made at once. The poison most in use is Paris green. This is applied in a mixture of 1 ℔. to 6 ℔. of dry air-slaked lime, dusted on the leaves from a bag of coarse cloth. The bag may be attached to a pole or grasped in the hand. A slight jarring or shaking of the bag will cause the mixture to sift out in a fine dust which settles on the leaves and when eaten by the cotton worms kills them.

The experience of many cotton growers has conclusively demonstrated that prompt treatment with Paris green in the beginning of an outbreak of the cotton worm prevents damage to the plant; while, on the other hand, instances are not wanting to prove the serious results of neglect at this time. In spite of all that has been said on the subject, there are managers and overseers who fail to discover the presence of the cotton worm in the fields until too late, and the damage is beyond repair.

Birds and insects prey upon the cotton worm but cannot be depended upon to hold it in check; therefore, intelligent and careful inspection of the cotton fields, and the prompt application of poison when the pest appears, are absolutely necessary to prevent injury to the crop.

COTTON STAINERS.

These insects are found in all the West India Islands, and, except in Barbados, have occurred in the cotton fields in such numbers as to be a pest.

In a previous paper two species of cotton stainers, *Dysdercus andreae* and *Dysdercus annuliger*, were described. The former of these is the common cotton stainer of the Leeward Islands, and the latter is the common form found in the Windward Islands. *D. annuliger* is also found in Barbados but is very rare. Since the descriptions of these species appeared, a third species has been found on cotton in Trinidad.

These insects are all alike in habit; they live by sucking the juices of the cotton plant from the leaves, stems, young bolls, or the soft seeds and fibre in the newly opened bolls. In addition to the injury thus caused, the cotton stainers injure the fibre by staining it with their yellowish excrement, while it is still in the boll, and by being caught in the gins and crushed.

The eggs are laid in the opening bolls where they hatch in five or six days. The young live among the ripening fibre for a few days, and then may be seen running very actively about on the plant or feeding with the proboscis inserted in the tender parts of the plant.

The young are bright red, acquiring their black or white or yellowish markings gradually as they grow older.

The Leeward Islands cotton stainer (*D. andreae*) is marked with black and white on a reddish ground-work, but there is no white ring on the terminal segment of the antennae. The Windward Islands cotton stainer (*D. annuliger*) is black and red on the back, and has a white ring at the base of the terminal segment of the antennae, as has also the Trinidad species; but this last is yellow and black above with a red head and red legs.

The cotton stainers are controlled by collecting and trapping. They are collected in buckets or tins containing a little water and kerosene oil which are held under the bolls or branches on which there are a large number of stainers. The insects are dislodged by beating or shaking the branch over the kerosene and water into which they fall. The film of kerosene very quickly kills them.

They may be trapped by putting down small piles of cotton seed in the field or about the buildings where cotton is stored. Large numbers of these insects will be attracted to these traps where they may be killed while feeding, by spraying with kerosene or drenching with hot water. Trapping will probably be found most useful at seasons when there is no cotton growing in the field, while collecting will be found most useful in the field as the bolls are opening.

Although cotton stainers have been at times very injurious to cotton in the United States, no serious loss has been reported in the West Indies, and it seems likely that, by the exercise of a little care, they may be kept sufficiently in check to prevent it in the future.

THE RED MAGGOT.

(*Diplosis* sp.)

The red maggot is the larva of a fly of the family of gall-gnats. In November 1903 a field of ratoon cotton at

Bushy Park, Barbados, was noticed to be attacked by this pest, and since then it has been found in fields of plant cotton in other parts of this island. On December 31, a few of these maggots were found in diseased cotton bolls sent from Montserrat.

The pale orange-red maggots about ⅛ inch in length, are to be found under the bark feeding on the cambium. There may be a few or many at a single point of attack, and there may be several points of attack in a single plant. The parent fly is very small, delicate, with long legs and long antennae. The body is pale orange, the wings and legs a mottled grey.

The eggs are apparently laid in wounds and breaks in the bark, but it seems likely that the maggots can penetrate the bark if the eggs are laid on sound bark. No remedies are known except cutting out affected branches and pulling out dead or dying plants that are known to be affected. Great care should be exercised by the labourers not to wound the plants either by breaking the branches or by bruising the base of the plant with the hoe.

Specimens of the parent fly and the maggot were sent to the Bureau of Entomology of the U.S. Department of Agriculture, and in reply Dr. L. O. Howard writes that the insect is a new species of *Diplosis.**

COTTON LEAF-BLISTER MITE.

(*Eriophyes gossypii.*)

This pest of cotton first attracted attention in Montserrat in July 1903, and was first investigated in September 1903. Since then it has appeared in Nevis, St. Kitt's, Antigua, Dominica, St. Lucia, St. Vincent, and Carriacou; Barbados has, so far, escaped.

The leaf-blister mite is a very small arachnid, not a true insect, about 0·1 mm. in length. It can seldom be seen even with a good pocket lens.

The first indication of the presence of the disease is usually a slight distortion of a few leaves. The infection probably always takes place in the bud and the distortion is to be seen at once on the unfolding of the leaves. Sometimes only a single leaf is slightly affected, and sometimes all the leaves on a plant are badly distorted, curled, and shrivelled up. If one of these galls or distorted portions of the leaf is cut open, it will be seen to be filled with whitish hairs. The growth of hairs is set up by the irritation of the mite, and large numbers of mites may be found among the hairs on a single gall.

Remedies.—So far, the application of sulphur has given better results than any other insecticide. It is used in a mixture with an equal part of dry air-slaked lime, in the same way that Paris green is applied.

This has been extensively tried in the Leeward Islands, and good results are reported. Extensive experiments are now

* Since the above was written, a description of this insect was published under the name *Porricondyla* (Epidosis) *gossypii*, in the *Canadian Entomologist*, see Appendix to this paper, pp. 128-9. [Ed. *W.I.B.*]

being tried in St. Vincent, where the rainfall is much greater, to ascertain, if possible, whether the sulphur and lime are washed off before doing any good. The object of an insecticide application must be to prevent the infestation of fresh buds from the galls in the leaves, to do which the mite is obliged to crawl over the surface of the plant.

It is not yet known what are the wild food plants of this mite, nor what means are employed in travelling from plant to plant, though birds, insects, and the wind are all believed to assist.

The life-history is not known, so that it is impossible to tell how long after the first infection any attack may become serious. At Conarees, in St. Kitt's, cotton which had been growing seven months was just showing a few affected plants in July, but fields in other places have been seriously attacked in a few weeks from planting the seed.

Sulphur and air-slaked lime dusted on the leaves, and cutting out and burning of badly attacked plants and parts of plants, are the only remedies that have proved of value in controlling this pest.

OTHER INSECT PESTS.

The other pests of cotton are of less importance and may be considered very briefly.

The cotton boll weevil (*Anthonomus grandis*), which has caused such serious loss in sections of the cotton-growing districts of the United States, has not yet appeared in the British West Indies, nor has the cotton boll worm (*Heliothis armiger*) been found attacking cotton bolls, although the adult moth has been captured in St. Vincent, and it probably occurs in small numbers in other places. The only attack of borers in the cotton bolls that has been reported to the Department was that at Codrington House in 1904. In 1903, a small plot of Peruvian corn was badly attacked by the corn ear worm (*Laphygma frugiperda*). The following season (1904), cotton was planted on the same land, and a few cotton bolls (about 100) were attacked by this insect. The affected bolls were picked off, and destroyed as soon as they were found, and no further attack has been reported.

The cotton aphis (*Aphis gossypii*) has not been a serious pest during the past year, and no instances are recorded of serious damage to the crop from this cause since the revival of cotton cultivation in the West Indies. In some fields the cotton aphis has caused a few leaves to dry up and drop off prematurely, but the plants have outgrown the attack. The two common species of lady-birds have been numerous and have greatly assisted in keeping the aphis in check.

Scale insects do not often become a serious pest on cotton. The time required for the development of the plants and the maturing of the cotton is so short that an infestation by these insects would very rarely become serious on first-crop cotton. However, when cotton is kept over for a second picking or ratooned for a second year's crop, the scales frequently become

so numerous as to weaken the plant. So far, spraying has not been tried and it seems doubtful if this would be a practical measure, at least until more definite results have been obtained from ratoons and second pickings. The scale insects which are found attacking cotton are the Hibiscus scale (*Lecanium nigrum*), the small snow scale (*Chionaspis minor*), and, recently, one of the mealy bugs (*Dactylopius sacchari*) has been found attacking a field of second-crop cotton in Barbados. The Hibiscus scale and the snow scale are found on the stems and branches, while the mealy bug is found at the base of the pod inside the bracts.

BENEFICIAL INSECTS.

The beneficial insects found on cotton are of two kinds, viz., the lady-birds that prey upon the cotton aphis, and the enemies of the cotton worm.

Two kinds of lady-birds are commonly to be found on cotton plants, the red lady-bird (*Cycloneda sanguinea*) and the spotted lady-bird (*Megilla maculata*). The enemies of the cotton worm are the wild bees and cow bees (*Polistes* spp.), the Jack Spaniards, and other wasps which prey upon the caterpillars, a hymenopterous insect (*Chalsis annulata*), which has been found as a parasite of the pupae, and a very small hymenopterous insect (*Trichogramma pretiosa*). which is a parasite on the eggs.

Several species of birds, also, feed on the caterpillars; and turkeys, poultry, etc., have on some estates been very useful in destroying large numbers of the cotton worm.

The lady-birds already mentioned feed on the cotton aphis, and, at almost any time, both the larva and adults may be seen on the cotton plants.

The lace-wing fly, a small green insect with four gauzy wings, also feeds on the aphis. The adult fly is very common in cotton fields, but the larva, even when present in considerable numbers, is not often to be seen on account of its green colour which so nearly matches the colour of the under side of the leaf on which it lives.

APPENDIX.

A NEW CECIDOMYIID ON COTTON.

The following description of the insect whose larva has been referred to in the preceding paper as the 'red maggot,' by D. W. Coquillett, of Washington, D.C., appeared in the *Canadian Entomologist* for June 1905:—

During the past winter Dr. L. O. Howard received specimens of a Cecidomyiid from Sir Daniel Morris, Commissioner of the Imperial Department of Agriculture for the West Indies, with the statement that the larvae live in the cambium layer of cotton plants. Up to the present time no representative of this family has been recorded as depredating upon cotton, so far as I am aware, and at the request of Sir Daniel Morris the species is duly characterized herewith:—

Porricondyla (Epidosis) *gossypii*, new species.

Antennae of male longer than the head and body together, composed of about twenty-one joints, of which the first two are sessile and scarcely longer than wide, the remaining joints, except the last one, with a bulbous basal portion bearing a whorl of bristly hairs and a narrow apical part, the latter being slightly shorter than the thickened part of each joint. Antennae of female about two-thirds as long as the head and body combined, composed of twenty-six nearly sessile joints, the first two joints somewhat conical, the others constricted in the middle, the third joint the most strongly so, each succeeding joint less constricted. Wings hyaline, third vein (the apparent second vein) strongly curved and ending below the extreme tip of the wing, small cross-vein very oblique and weakly sigmoid. Colours yellow, the sternum and greater part of mesonotum brown, head blackish, antennae of female and the enlarged portions of those of the male brown, the constricted portions of the male antennae white, legs dusky-whitish. Length 1·5 mm.

Described from several dry and shrivelled specimens of both sexes. Type No. 8,399, U.S. National Museum. From Barbados, West Indies.

The full-grown larvae are yellowish-white, the median portion chiefly orange-red: the skin is smooth except on the under side, where there are many minute tubercles arranged in about six irregular transverse rows on the median portion of each segment. The breast-bone is yellow, cylindrical, and with a small knob at the anterior end. The larvae live beneath the bark of cotton plants without forming galls.

RAIFFEISEN AGRICULTURAL BANKS.

BY THE HON. W. FAWCETT, B.Sc. F.L.S.

Agricultural Loan Banks on a popular basis are much wanted in Jamaica, and probably, also, in the rest of the West Indies.

I propose to lay before you a statement of the principles that, I think, would guide us in the formation of such banks.

At no time was the necessity for people's banks in Jamaica so manifest as after the hurricane of August 1903. The peasant proprietors of devastated fields were inclined to be apathetic, fatalistic. Owners, generally, large and small, were in want of cash to put their properties in order, and ensure crops for the following year. The Government came promptly to the rescue, sending out agents to rouse and instruct, and distributing broadcast leaflets of agricultural advice. For those who wanted money, a system of temporary government loans was organized. This step strengthened credit; large

estate owners obtained relief from banks in the ordinary way; while to those who preferred it, government loans were granted.

HURRICANE LOANS LAW, 1903.

I will give some details of this system of government loans, as it may be taken as a suggestive example in case government banks are ever instituted.

A law* was passed, September 18, 1903, of which the preamble ran thus:—' Whereas in view of the damage done by the hurricane of the 11th. day of August 1903, it is desirable to empower the Government of Jamaica to make temporary loans to those who have sustained damages by the hurricane, and to provide simple and efficacious means of making and securing the repayment of such loans.'

The rights conferred on the Government in respect of these loans were: a preferential charge upon the crops, a charge upon the land, and a power to sell the borrower's interest in the land on default of repayment according to the specified time and manner.

The borrower was to covenant: to use the loan on the cultivation of the land; to repay the loan with 6 per cent. interest and all expenses incurred; to produce, if required, at stated intervals, and vouch for its accuracy, an account of expenditure; to allow inspection of the land by government agents; to uphold cultivation so that the security is not deteriorated; and, if required, to inform the agent of sales and contracts for sale of produce, and give an order on the purchaser for purchase money to be applied to repayment.

The Colonial Secretary was appointed Chief Loan Officer; the Auditor General and a clerk in the Colonial Secretary's Office were also Loan Officers.

The conditions under which loans were granted were:—

(1) That no loans were to be granted where the area in cultivation was less than 5 acres, unless the applicant was unable to work on his own land and had to obtain asistance.

(2) No more than £3 an acre was to be lent.

(3) The loans to be advanced in seven monthly instalments.

(4) The rate of interest, 6 per cent. per annum, calculated monthly.

(5) Loan to be repaid, one-half on May 15, 1905, one-fourth on June 15. 1905, and one-fourth on July 15, 1905.

(6) In case of default, the Loan Officers had the power to assign the produce of the borrower's land to nominated buyers.

The afflicted parishes were divided up into small districts,

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* Jamaica Law No. 47 of 1903. *The Hurricane Loans Law, 1903.* [For further information on the operation of this law reference should be made to Pamphlet No. 35, 'Information in regard to Agricultural Banks.' Ed. *W.I.B.*]

and local committees appointed in each district to advise the Loan Officers confidentially of the trustworthiness and ability to repay of each applicant for a loan. Help was given by some of the Instructors and Revenue Officers, and a Travelling Agent was appointed. No salary was granted to any Officer in respect of his services, except to the Travelling Agent. The expenses have thus been kept low, and it is anticipated that the 6 per cent. interest charged will not only repay Government 3 per cent. on the money advanced which would have been earned on deposit, but also all the incidental expenses.

There were 2,983 applicants for loans, and after inquiry loans were granted to 1,477 persons, amounting altogether to £36,704.

The full amount of £3 per acre was not in all cases granted or claimed. If a rough calculation be, however, made, and the £36,704 be divided by 3, we get 12,235 acres, chiefly bananas, amongst 1,477 borrowers—an average of 8⅓ acres per borrower.

As the time for repayment has not arrived, it is impossible to say yet whether all the loans will be repaid without default, but the Government does not anticipate any loss.

AGRICULTURAL BANKS FOR JAMAICA.

The presumed success of the government loans has greatly encouraged those who have for long been desirous of attempting the establishment of people's banks on the model of that marvellous and admirable system invented by the genius of Raiffeisen in Germany more than fifty years ago.

In the first place, it was most encouraging to find so many persons of high standing in the community ready to serve on the local committees for the benefit of their neighbours. Our experience in the branches of the Agricultural Society had already shown this spirit of devotion on the part of some of the landed proprietors, ministers of religion, and others, but here, where the need was evident and pressing, there was a universal exhibition of willingness to co-operate in assisting the Government freely and without recompense. By so doing they naturally increased the security of the loan, and helped to keep the rate of interest low.

Again, it was noticed with satisfaction that it was considered feasible to grant loans to the owners of only 5 acres of land if it was all under cultivation.

I would call attention to special points in the precaution, taken by the Government:—(1) Loans were granted only to those who were recommended by the local committee, who from personal knowledge believed that repayment in full could, and would, be made. (2) The loan was granted for a specific purpose. (3) The local committee, or the government agent by personal supervision, took care that the loan was properly applied. (4) Repayments of loan were not asked for until such time had elapsed as was necessary to allow the loan to become productive. (5) The power of at once calling in the loan, if repayments were not punctual.

These precautions are similar to some of the rules laid down by Raiffeisen, but they do not go so far—they cannot reach the very poor man, nor do they make the repayment so secure as in his banks.

I do not intend to enter into the question of Planters' Banks, my subject is People's Banks. For them I do not advocate the formation of government loan banks. I think the system of Raiffeisen in every way, both from an economic and an educational point of view, more suited to our needs. I will therefore now indicate the main and essential features of that system as portrayed in the writings of Henry W. Wolff,* and, as far as possible, in his own words.

The foundation of the system is the unlimited liability of each and all the members of the bank.

In the Scotch Credit System, which did such wonders for Scotland in the early part of last century, there is the principle in germ, but in germ only. The Lords and Commons Committee of 1826, in reporting on it, says: –

'Any person who applies to the bank for a cash credit is called upon to produce two or more competent securities, who are jointly bound, and after a full inquiry into the character of the applicant, the nature of his business, and the sufficiency of his securities, he is allowed to open a credit . . . . This system has a great effect upon the moral habits of the people, because those who are securities feel an interest in watching over their conduct; and if they find that they are misconducting themselves, they become apprehensive of being brought into risk and loss from having become their securities and if they find they are so misconducting themselves, they withdraw their security.'

Here are the two main pillars of co-operative credit recognized—joint liability and individual checking. The sureties become an intermediate body between capital and want, helping the latter but also effectually safeguarding the former.

But this is co-operative banking applied to people who possess property and also some commercial education. Raiffeisen's object was to dive deeper and so he proceeded upon broader and more popular lines. He multiplied the sureties, and quickened the vigilance and control by responsibility carried still further.

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*(1) *People's Bank: A Record of Social and Economic Success*, 2nd. Edition. London: P. S. King & Son. 7s. 6d.

(2) *Agricultural Banks: Their Object and their Work.* Agricultural Banks Association. London. 1s.

(3) *Village Banks, or Agricultural Credit Societies for Small Occupiers, Village Tradesmen, etc.* How to start them—How to work them—What the rich may do to help them; with Model Rules and Model Account Sheets dated. London: P. S. King Son. 6d.

(4) *A People's Bank Manual.* London: P. S. King & Son. 6d.

The fundamental idea of co-operative credit banking is that a number of persons, all quite poor, or poor and rich combined, join together to pledge their credit in common, in order thereby to obtain the temporary command of money, which, individually, they cannot secure, with a view to disposing of that money among themselves for temporary employment and for profitable purposes.

If we can ensure repayment from members and thereby secure—*absolutely* secure—those who virtually pledge all that they possess, we create a good foundation for credit, and make the scheme practicable. This is done by selecting the members, by watching the borrower, by watching the loan and reserving power for calling it in, and by subordinating everything that is done to the one consideration of safety.

The unlimited liability of all the members of the bank directly serves to supply all this.

Without unlimited liability you can never make sure that your bank will be sufficiently careful in the selection of its members. Such selection, limiting the membership to persons absolutely trustworthy, is the first condition of success. With only his 5s. or £1 share at stake, no person would care to say 'No' to the application for admission of any but an openly disreputable neighbour. But make people understand that in electing the new member they practically make themselves liable for any default which he may make, and all considerations of etiquette and mere neighbourly courtesy are sure to vanish. This strictness in election is one of the causes which make these banks such wonderful moral reformers. When a man knows that before he can be admitted to share in the advantages of a cheap lending institution, his character will be submitted to the searchlight of his neighbours' knowledge, the idle will become industrious, and the reckless careful.

Next, unlimited liability secures good administration. It ensures that the most competent men shall be elected as officers, and the unlimited liability which the officers share with the other members leads them to be extremely critical in their disposal of bank moneys, and very strict in their demand of prompt repayment, which is one of the essential conditions of success, economic and educational.

Without unlimited liability, furthermore, there could not possibly be all that watchfulness and control which keeps everything safe. The borrowers must remain honest, thrifty, careful, and deserving of credit. The employment of the loan is watched and its application to its proper purpose—failing which it is called in unmercifully—otherwise there can be no success. Prompt payments are insisted upon. The whole fabric is built up upon a system of mutual checking, the borrowers being checked by the committee, the committee by the council, the council by the mass of members—all without offensiveness, all in the interest and for the protection of the very people checked. All that zealous, lively, warm, and loving interest in their local association, which is such a feature among members of Raiffeisen banks, is plainly traceable to the

principle of unlimited liability which makes everyone feel that he and his fellows have become 'members one of another.' Under this system an association becomes what every genuine co-operative association should be—an honest and industrious family with a community of aims, of interests, and of sympathies.

Another very important element of success is the smallness of the district assigned to every bank. In any but a small district there cannot possibly be that knowledge and vigilance and checking of one another which constitutes a *sine qua non* of success.

The organization of the association is entirely on democratic lines. No difference of any sort is recognized between poor and rich, except that the rich, bearing the brunt of the liability, are by accepted understanding allowed also to take the leading part in the administration. The Committee consists of five, and is charged with all the executive work. The Council of Supervision consists, according to the size of the district, of from six to nine members, and is entrusted with checking and supervising the Committee, overhauling all that it has done at least once a month. And on both Committee and Council it is understood that the richer members should be in a majority.

Neither members of the Committee nor members of the Council of Supervision are allowed to draw a farthing of remuneration, be it in the shape of salary or of commission. Every chink and crevice is deliberately closed against the intrusion of a spirit of cupidity or greed, so as to make caution and security the sole guiding principles of action. A salaried officer may not feel so free to refuse an application for a loan, and may not be able so easily to consider business purely on its merits. One man only is paid--the cashier; and he has no say whatever in the employment and distribution of money, being merely an executive agent.

The simplicity of business ensures safety. The rules of Raiffeisen banks forbid most positively 'banking' in the ordinary sense of the term, or risk, or speculation of any kind. Their business is simply to lend and to borrow. If a loan should go wrong, under such circumstances, you know exactly what you can, at the worst, be made liable for. That £1 or £10 *absolutely* limits your loss. And joined to this simplicity of business is the simplicity of business arrangements, book-keeping, organization, and so on. Everything is simple, everything is intelligible.

As the rules were originally framed, no member was asked to pay down anything on joining, either for shares or in entrance fees. The German Government overruled this regulation and insisted that there must be shares. The Raiffeisen associations met this dictation by making their shares as small as possible, generally 10*s.* or 12*s.* payable by instalments.

No dividends or distribution of profits are allowed under any circumstances. One of the essential features of the organization is that individuals are to derive no benefit except

the privilege of borrowing, and every farthing which is left over out of transactions is rigorously claimed for the reserve fund, which is an entirely peculiar feature. It belongs wholly to the bank, and must not be shared out on any pretence. It is really the backbone of the whole system. Very small at first it grows very slowly, only increasing little by little, but in the course of time it becomes 'an impregnable rock of financial solvency.' The first object is to meet deficiencies or losses for which only with hardship individual members could be made responsible. Its next is to supply the place of borrowed capital, and so make borrowing cheaper to members. Lastly, should it outgrow the measure of such employment, it may, at the discretion of the society, be applied to some public work of common utility benefiting the district. The rules of the bank should clearly state, that, even if the association should be broken up, the reserve fund should remain intact in the hands of trustees until another association is formed, failing which in reasonable time, it should go to some public object for the benefit of the district. Thus no temptation can arise to break up the association for the sake of dividing the reserve fund. The existence of such a fund binds members together, for all are naturally anxious to retain their interest in it; they strive to continue worthy of membership, and others are attracted and incited to make themselves morally eligible.

The practice of lending is on the same lines of caution and stability. Although the association exists for the very purpose of lending, it deliberately makes borrowing not easy, but difficult. Every borrower must prove not only that he is trustworthy but that his enterprise is economically justified. Moreover, he must bring the signatures of two members as sureties on his application form, who promise to be jointly liable with him. He may be so sanguine as to be sure in his own mind of success, but the object must be scrutinized and accepted first by his sureties and next by the Committee. Once the money is granted, it must be applied strictly in that particular way for which it was asked.

Once every month the Council of Supervision meets for the special object of reviewing the position of debtors and their sureties, and considering the employment given to the loan money. Should a surety be found to have seriously deteriorated in solvency or in trustworthiness, a better surety is at once called for. If he is not forthcoming, or if the debtor is found to be misapplying the money, the loan is at once called in at four weeks' notice.

Another safeguard is to insist that interest and principal must be paid to the very day. The principal, for loans running any length of time, is made repayable by equal instalments, and prompt and punctual repayment notonly facilitates the carrying on of the business, but is far more valuable still as training the borrowers to habits of punctuality.

The method adopted in lending is made as simple and as intelligible as possible. All that, as a rule, is asked for is a note of hand; unbacked, or else backed by one surety, or more

generally by two, according to circumstances. That precludes all raising of money by passing or acceptances. Every farthing that is wanted, as far as it is not supplied by the savings or other deposits paid into the bank, has to be raised by borrowing. At the outset this may appear rather a cumbrous proceeding. But what with a high reputation secured by exemplary business habits, and the substantial guarantee of unlimited liability of all members, the banks have long since gained for themselves a position commanding such very easy credit, that they have no difficulty whatever in borrowing all that they want either from public banks, or from private individuals, at the cheapest market rates. Confidence in this security is so well established that in Germany Law Courts actually allow trust moneys to be paid into them on deposit.*

The Raiffeisen system of agricultural loan banks has worked wonders in Germany and in other European countries. It remains to be seen whether it can be successfully adopted in the West Indies. But our Agricultural Societies in Jamaica have shown such good examples of co-operative effort in many ways, that we are somewhat sanguine.

We have lately been directing the attention of our people to the system, and I believe that no less than three banks will be started during the present month.† It is a hopeful sign, full of promise for the New Year.

DISCUSSION.

The Hon. B. HOWELL JONES (British Guiana): The question of people's banks has very recently been brought before the Royal Agricultural and Commercial Society of British Guiana in a paper read by Mr. Luke Hill, who has paid a good deal of attention to the matter, especially to the system of people's banks existing in Ireland, which has been introduced for some

*There is another form of Loan Bank which has also done good work in Europe, that is, the 'Credit Associations' of Schulze. Schulze required unlimited liability, selection of trustworthy officers, and sound rules; but the keystone of his system was the compulsion to save regularly and steadily. Every member is expected to take one share and one share only. He is not allowed to take more, in order to prevent the association from being captured by capitalists. The value of the shares was fixed very high, at first about £50 paid up by instalments which may be very small. With the help of the capital in course of formation, of savings deposited, and of the credit which the small capital and unlimited liability of a large number of members give, the associations are in a position to raise all the money required. The interest was at first high. These banks are not particular about the object of the loan or the person of the borrower, but they demand security in the form of mortgages, pledges, sureties, bills. The loans may be large or small, according to the security offered, but must be for short terms—for three months, with renewal for another three months occasionally permitted. Business is carried on by a Committee of three who are elected and paid a salary, with a commission added. To check the Committee and to audit these accounts a Council of Control of nine members is also annually elected. It is considered well to have as large and as mixed a constituency as possible, consisting of members of all callings, whose blending will equalize supply and demand of money, security, and risk. The Credit Associations aim at high dividends by the largest possible extension of their business. This leads to speculation for the sake of gain, and very often ends in disaster.

† These three Banks started in the parish of Manchester are not Raiffeisen, but rather on the lines of Schulze's Credit Associations, except that the liability is limited to the amount of one share.

time and is working extremely satisfactorily.* The starting of these banks in British Guiana is receiving the attention of the Agricultural Society; but at the present time I am afraid the feeling with regard to them is rather pessimistic, because we do not think the people are of a sufficiently high standard and character, and they do not trust one another sufficiently to co-operate in the manner which has been adopted in the Raiffeisen system or that carried on in Ireland. In British Guiana there has always been a feeling of comparative distrust amongst the people, and in establishing these banks the people must have complete confidence in one another, because the banks must be established and carried on by the people themselves, and can only be successfully managed in small areas. In British Guiana the areas in which these banks will have to be formed are comparatively large; our population is separated in large villages containing sometimes as many as 8,000 or 9,000 people, composed of almost every race of human being under the face of the sun. In these villages there exists a feeling of distrust among the people according to the race from which they spring. At the same time it is hoped that these banks will be attempted, because there undoubtedly exists among the small class of cultivators a great want of capital to cultivate their land and obtain remunerative crops. It would not always be easy for the people in British Guiana to repay loans at certain periods of the year, because we suffer far more than they do in European countries the serious effects both of floods and severe drought, and I am afraid, in many cases, loans made to people would have to be carried over to a further period than that to which their repayment was limited, and the bank would suffer very considerably from not having the repayment of the money at the time it became due. These are matters for consideration, and, in addition to these, I think a great deal depends on local circumstances. In the starting of the first bank a great deal would depend on the character of the men forming the Committee and those joining the bank as borrowers; but it must be a foundation of people's banks that every one connected with it must be honest, upright, trustworthy, thrifty, and careful, and unless banks are established by people with these attributes they cannot succeed. However, there can be no harm in trying these banks, and I believe an attempt will be made by persons who are interesting themselves in the matter.

Dr. H. A. A. NICHOLLS (Dominica): Some short time ago, as Vice-President of the Dominica Agricultural Society, I was approached by some members who desired that I should bring before the society the question of establishing an agricultural bank in the island. The want of such an institution has been very much felt for a number of years, for it must be remembered that there is a large body of peasant proprietors at Dominica, many of whom have land, and who by themselves and their families can provide the necessary labour, but have not the money wherewith to bring up their cultivation to a point which will make them successful planters in their particular spheres.

*Mr. Hill's paper was reprinted in Pamphlet No. 35, 'Information in regard to Agricultural Banks.' [Ed. *W.I.B.*]

It was felt by these men, and also by others who occupy a high station in life, that for such a section of the population a bank would be a good thing. I think I may say, also, that for St. Lucia, St. Vincent, and one or two other islands similarly circumstanced, such institutions would be of immense service. It appears to me, therefore, that the colonies I have mentioned will be willing and anxious, perhaps, to express their thanks to Mr. Fawcett for having brought this question before the West Indies in such a lucid manner. Everything that he has said will no doubt be scrutinized very carefully in these islands, and I trust that his initiatory efforts will result in the establishment of banks in such islands. When I was approached by certain members of the Dominica Agricultural Society, I knew that Mr. Fawcett was going to bring up the question, and I suggested that it would be better to wait until the Agricultural Conference was over, and then we would be able to see what Mr. Fawcett brought forward; and, moreover, we should then probably have an excellent form on which we might base our efforts. With Mr. Fawcett's permission I will bring before the Dominica Agricultural Society the plan he has put forward, and I trust that something satisfactory to the island will result therefrom.

The PRESIDENT: I think the suggestion made by Dr. Nicholls should be generally followed; that is to say, the question should be brought before the Agricultural Society in each island.

Mr. J. H. COLLENS (Trinidad): The question of agricultural banks came before the Agricultural Society of Trinidad some two years ago, and a Committee, of which I had the honour to be a member, was appointed to consider the matter. Mr. Ludovic deVerteuil was here at the same time, and gave us a good deal of information on the subject; and with the help of his knowledge the Committee came to the conclusion that, if it were possible to establish a bank at all, it should be based on the Raiffeisen system, which seemed to be the most economical and the safest that could be copied. The society adopted the Committee's report.

Mr. J. A. HARBIN (Grenada): Mr. Fawcett says that the subordination of everything to the idea of safety and the establishment of a safeguard between capital and want are the two great points in connexion with his scheme. I should like to ask him whether associations formed for the disposal of produce on behalf of labourers might or might not be considered as coming within the legitimate intention of the scheme which he has proposed.

The Hon. W. FAWCETT: Associations of all kinds spring up side by side with banks of this description, and the banks lend money according to their discretion. The banks will have to be very careful in making loans. With regard to the difficulties which Mr. Howell Jones has mentioned, I do not think there are greater difficulties here than in Europe. There, no difficulty is experienced in regard to race. The main point is that the managers must personally know the persons to whom they make loans.

RUBBER CULTIVATION IN THE WEST INDIES.

The PRESIDENT: The cultivation of rubber trees in different parts of the tropics has been taken up with great energy, and considerable success has been attained in Ceylon and the Straits Settlements especially with Para rubber. The commercial value of rubber is steadily increasing, and in view of the numberless uses to which rubber is put, there is no doubt that if plantations of rubber trees could be successfully carried on, either alone or in connexion with other industries, they might prove profitable in some parts of the West Indies. In British Guiana rubber trees of several kinds already exist, and one would naturally suppose that in that colony a rubber industry might be established under more favourable conditions than anywhere else. The more recent idea is to establish regular plantations, and these, as far as I am aware, have only been started at Tobago and Trinidad. In the former island rubber plantations have been started now for over twelve years, and they are beginning to yield commercial rubber. I have asked Captain Short, of Richmond, to prepare a paper showing the results of rubber cultivation in Tobago. He has sent a most interesting paper with results compiled by himself and Mr. T. L. M. Orde, the manager of Louis d'Or, a plantation belonging to the West India Rubber Syndicate.

CASTILLOA RUBBER IN TOBAGO.

By Captain M. SHORT, of Richmond, Tobago.

The Castilloa is practically the only rubber tree grown in this island. There are a few acres of Ceara (*Manihot Glaziovii*), and a small quantity of Para (*Hevea brasiliensis*) and African (*Funtumia elastica*), but although the growth of these two latter species seems fairly satisfactory, it is too early yet to judge if they will eventually flourish and yield well here.

There is no doubt, however, that in the chief cacao-growing districts the Castilloa thrives remarkably well, and the tree appears to grow equally well at an elevation of 900 feet as at sea-level. Some few trees, up to three and four years of age, have at times been attacked by blight, but in the larger number of cases where this has occurred, the young trees have succeeded in throwing it off, without spraying being resorted to, or, where the tops have died back, have sent out flourishing suckers.

SHADE FOR CASTILLOA.

In good soil and in moist situations, no shade at all is required for the young tree, but otherwise it does want a certain amount of shade for the first two or three years after planting. Too dense a shade, however, is not beneficial to it, and plants set out in the forest make very slow progress, and develop into spindly trees.

Where three- to six-year-old trees are shaded by Bois Immortel or other large trees, as might be expected, they

increase rapidly in height, but where they are planted fairly close, or where the stem only is shaded by bananas, etc., the tree thickens out as it grows.

SIZE OF TREES.

There are about 90,000 Castilloa trees in the island. The oldest are those on the Richmond estate, where 100 to 150 were planted thirteen to fourteen years ago. The largest of these now measures 6 feet in circumference at 3 feet from the ground. Some measurements were taken in December 1898, when the trees were eight years old, the largest being 5 feet in girth at 3 feet from the ground. Others measured 3 feet 9 inches, 3 feet 5 inches, 3 feet 1 inch.

YOUNG CASTILLOAS.

Mr. Orde, who is managing the West India Rubber Syndicate, has kindly furnished the following information on young Castilloas :—

The Castilloas on Louis d'Or estate are still young. Planting was begun in the autumn of 1898, and the oldest trees are six years or thereabouts.

The larger number of the trees have been planted to stand finally at a distance of 17 feet. Some fields are planted at 8½ feet by 8½ feet, others at 8½ feet by 17 feet, in the hope that a yield might be obtained from the cultivation while young, by tapping the intermediate trees before they grew large enough to necessitate being cut out.

It has been found that a well-grown field, planted at 8½ feet by 8½ feet, cannot stand longer than about five years without being thinned out, as at that age the branches begin to interfere with each other, and the tree tends to become thin and spindly.

Experiments were made in tapping some of these young trees, averaging five to six years old, in 1904. Large numbers of them were tapped as severely as possible with chisel and mallet. The latex was in some cases taken wet and washed before coagulation, and in others it was allowed to dry on the tree, and picked off afterwards as scrap.

The yield obtained was very small, averaging ¼ oz. per tree, though individual trees gave more. In one case, 160 of the best-grown trees were tapped, the rubber being taken wet, and the yield from these was rather over 5 lb. of dry rubber, or an average of ½ oz. per tree.

Small lots of this rubber have been sent to London for valuation, and good prices have been quoted, 2*s.* to 2*s.* 6*d.* being quoted for the scrap, and 4*s.* 2*d.* to 4*s.* 8*d.* for the washed rubber. No large quantity has yet been put on the market.

It is not yet known how frequently trees of this age can be tapped and made to yield an amount worth the cost of collecting. It is possible that they might stand three tappings in the year, which would bring the yield up to about 1 oz. per tree. The cost of collecting the rubber as scrap is from

6d. to *7d.* per lb., while, if the latex is taken wet and washed, the operation is more laborious and the cost per pound increases. There are some twenty to thirty trees on the estate, aged seven years from seed, and experiments have also been made on these, from which it appears that the yield increases fairly quickly as the tree gets older.

Six of these trees were tapped, not severely, in March 1904, and gave 12¼ oz. dry rubber. The same trees were tapped again in September and gave 10 oz., or nearly ¼ lb. per tree in the two tappings. These trees, however, were rather above the average in growth for their age.

Trees planted at 8½ feet by 8½ feet could not be left growing to this size without injury to each other; and if a field is planted with the idea of getting rubber from the intermediate trees, as soon as they get old enough to yield, and before it is necessary to cut them out, it would seem that 8½ feet is too close a distance, and that 12 feet would be about the most suitable distance.

In a field planted at 12 feet by 12 feet, and intended to stand permanently at 24 feet by 24 feet, the intermediate trees could probably be allowed to attain an age of eight or nine years before being cut down. In such a field there would be about 225 intermediate trees per acre on which to work. Basing a calculation on a yield of 4 oz. per tree in the seventh year, the yield works out at 56 lb. of rubber, which, at *2s. 6d.* per lb., and deducting *6d.* per lb. for the cost of collection, shows a profit of £5 *12s.* per acre.

These tappings might be continued in the eighth and ninth years, with a probable increase in yield each year, at the end of which time the intermediate trees would be cut down, and the tapping of the permanent trees begun.

DISTANCE OF PLANTING.

The conclusion to be arrived at from these facts seems to point to close planting being advisable in order to ensure a comparatively quicker return, but it is doubtful if it would be worth while to plant closer than 10 feet, and I am inclined to agree with Mr. Orde that 12 feet is the best distance to adopt.

YIELD OF LATEX.

Tapping was first started on Richmond estate in November 1899, the trees being then about nine years old. One hundred and twenty-two trees were tapped, the average yield being 2 oz. to 2½ oz. dry rubber at one tapping. One tree was tapped four times at a week's interval and gave in all 9¼ oz. dry rubber:—

No. 1	tapping	gave	3	oz.	dry rubber
„ 2	„	„	2½	„	„ „
„ 3	„	„	2	„	„ „
„ 4	„	„	1¾	„	„ „

In May 1903, thirty trees, then twelve to thirteen years old, were tapped every second day for twelve days. A row of cups was placed round each tree, commencing 6 feet up on the first

day, and oblique cuts were made with the chisel as high as could be reached from the ground. At the second tapping the cups were placed 5 feet up and so on, a foot lower each time. The total amount of rubber obtained in the six tappings was 16 ℔. 10 oz., an average of nearly 9 oz. per tree:—

No. 1 tapping averaged per tree	2¼	oz.	dry	rubber.
„ 2 „ „ „ „	2	„	„	„
„ 3 „ „ „ „	1⅞	„	„	„
„ 4 „ „ „ „	1⅞	„	„	„
„ 5 „ „ „ „	1⅛	„	„	„
„ 6 „ „ „ „	1	„	„	„

This method of tapping has been discontinued, as it was found that the process of putting on the cups at various heights the same day was both quicker and less expensive in the end, while the total yield was equally good.

These thirty trees were tapped again twice in February according to the latter method, the average yield being then 5 oz., making the total yield per tree in the eight to nine months 14 oz.

Tapping was carried on in February 1904 with the following results:—

		Total yield.	Average per tree.
Feb. 4,	19 trees gave ...	4 ℔. 6 oz.	3¾ oz. dry rubber.
March 19,	same „ ..	3 „ 10 „	3 „ „ „
Feb. 8,	16 trees „ ...	4 „ 1 „	4 „ „ „
March 15,	same „ ...	2 „ 11 „	2¾ „ „ „
Feb. 17,	15 trees „ ...	5 „ 11 „	6¼ „ „ „
April 27,	same „ ...	3 „ 0 „	3 „ „ „

These fifty trees gave an average yield of just under ½ ℔. of dry rubber in the two tappings.

The yield of latex varies greatly in trees of the same size and age. Two trees out of these fifty gave 7½ to 8½ cups of latex at each tapping, the one tree yielding 1 ℔. 10 oz. of dry rubber in the two tappings, the other 1 ℔. 9 oz. Other trees tapped in the same month gave 1 ℔. in the two tappings, and another gave ¾ ℔ in one tapping. Trees of the same age and size gave less than half these amounts. Why this should be I cannot say, and I believe no explanation has yet been given to account for the difference in the yield of latex. As far as my own observation goes, trees in the open, or only partially shaded, appear to be better yielders, as a rule, than those in denser shade.

In comparing this tapping with that of 1899, it appears that, at nine years old, a tree on an average yields about one-half of what a tree thirteen to fourteen years old does.

The results of the different tappings have led me to conclude that from ¾ ℔. to 1 ℔. of rubber per annum may be safely reckoned on, as the average yield of a tree thirteen to fourteen years old.

It is intended at the next tapping to use a ladder, and to tap as far as possible up the stem. No doubt the total yield

of rubber would then be greater. It is also intended to tap a few trees continuously for twelve to fourteen days, or every second day for a month, although it is very doubtful if the yield of latex would be much increased by so doing, or that the extra yield so obtained would compensate for the greater damage to the tree. In this respect the Castilloa appears to differ from the Para, and the experiments to be tried in 1905 will probably do something towards settling the point.

The cost of collecting was 8*d.* to 9*d.* per lb., but this cost would be reduced when tapping is carried on regularly and on a larger scale. The rubber extracted from the nine-year-old trees in 1899 to 1900 was valued at 3*s.* 9*d.* per lb., a good price at the time.

MODE OF CLEANING.

The rubber extracted in 1899-1900 was mixed with water and put through a cream separator. The result was good, clean, pale rubber, but the difficulty in extracting the rubber from the bowl rendered this process impracticable on a large scale with the machine in use. Later on, the latex was mixed with five times its volume of water, strained and skimmed after settling. This is a long process, as, after the first washing or two, the rubber takes two or three days to coagulate. The rubber, when dry, is very dark. The colour of the dry rubber, however, according to the most recent information, does not affect the price.

CASTILLOA AS SHADE FOR CACAO.

There is little doubt that the return per acre would be greater from a plantation of cacao and Castilloa than from cacao shaded by Bois Immortel. On Richmond estate there is an acre of cacao twelve and a half years old, planted at 12 feet by 12 feet, shaded by Castilloa and Bois Immortel. The rubbers are at 24 feet by 24 feet. The Immortel are being gradually killed, many of them being already dead. The cacao crop for 1903-4 from this field was 3 bags. This would give a return per acre of from £22 10*s.* to £25 3*s.*, thus:—

3 bags cacao at £4	£12
75 rubber trees ¾ lb. each at 3*s.* 6*d.* per lb.	10
	£22

If the average yield were 1 lb. per tree, this would give a return of £25 3*s.* per acre.

The return from other cacao fields of the same age, planted on similar soil and shaded by Bois Immortel, was from 3½ to 4½ bags per acre. Taking the average of 4 bags, this gives £16 per acre, so that, deducting the cost of the rubber extraction, the return from the cacao and rubber would be from £4 to £6 more.

By applying some nitrogenous manure to supply the deficiency in the soil arising from the absence of the Bois Immortel tree, this figure would doubtless be increased. It is also probable that the rubber could be planted closer than 24 feet.

INFORMATION REQUIRED.

There are several points on which rubber growers are anxious to obtain information, among these being:—

1. A method of tapping the tree that would dispense with the claying of the cups, and also any improvement on the method of tapping with the chisel and mallet.

2. The reason of the difference in yield of latex in trees of the same age and size.

3. Whether the yield of latex could be increased by the application of manure, and if so, what particular manure.

4. The constituents in the soil specially required by Castilloa.

5 In making oblique cuts in the tree, it is believed that a cut given upwards is preferable to a downward cut. Why is this?

6. With Para rubber the yield increases after the first few tappings when carried out on consecutive days, but this does not appear to be the case with Castilloa. It would be interesting to find out the reason of this.

A cut on the Castilloa, of course, drains a greater extent of the tree at the first tapping, but why does the yield of the Para, which is small comparatively on the first days of tapping, increase?

It is hoped that some members attending the Conference may be able to give some information on these points.

The PRESIDENT: Mr. Hart has closely associated himself with the question of rubber planting in these colonies, and I would ask him to review Captain Short's paper adding any further information he may have on the subject.

Mr. J. H. HART (Trinidad): Captain Short states that it appears that Castilloa rubber will grow well at 900 feet above sea-level. I think he is quite correct in that statement as I have seen Castilloa growing in its native country, Central America, at that elevation. I cannot, however, follow him in the statement made in one part of his paper, taking it with that made in another part in connexion with shade. He is of opinion that no shade is required for Castilloa in good soil, but that it requires a certain amount of shade for the first two or three years. This would seem to show that Castilloa does require shade in some places. Experiments carried out in Trinidad prove most decidedly that Castilloa does require shade. It does not grow with the same vigour when exposed to sun as when partially shaded. I do not mean by shade, such shade as is given to cacao, but a growth of trees of similar size by the side of Castilloa, as it would grow in its natural forest. Dr. Weber, in late writings in the *India Rubber Journal*, expresses the same opinion and comes to the conclusion that Castilloa requires protection of the stem by the growth of trees around it both in the young and mature stage. He came to that conclusion after a short visit to Central America. I am of opinion that trees will grow at 50 per cent. greater rate if shaded than if not shaded, and if left unshaded they

will die: while those planted in the wood, as I can show you on the lands of the Botanical Department, continue to grow vigorously and scatter their seeds widely around.

The PRESIDENT: Would you now discuss the question whether Castilloa trees should be used as shade for cacao?

Mr. HART: Captain Short seems to be in favour of it, but it seems to me that a tree which itself requires to be shaded with a tree equally its own height, would scarcely be of value as a shade for such a low-growing tree as cacao, found indigenous in Trinidad as a tree of the undergrowth of the forest.

The PRESIDENT: Would not that vary with the climate as in the case of cacao itself?

Mr. HART: Probably: but I am speaking entirely on Trinidad and Central American experience. In Grenada, where shade is not required, it is possible that Castilloa will grow equally as well without shade as cacao now appears to do.

With regard to tapping, the cultivation of rubber is yet in its infancy, and the methods of extracting rubber are, up to the present time, merely matters of experiment. We have tried experiments with tapping rubber generally, and tapping at different ages. These experiments have shown that the latex from young trees contains a very much larger amount of resin, and that the older the trees get, the larger the amount of rubber. In some instances the rubber flows slowly and coagulates before it can run down to the cup. In such cases it was probably tapped in dry weather. After heavy showers the latex runs more freely and contains much more water. I do not think that need interfere with the operator because it is necessary to add a certain proportion of water to the latex before you can clean it and prepare it for perfect coagulation. The amount of rubber contained in the ducts of different rubbers—*Funtumia clastica*, *Funtumia africana*, *Castilloa elastica*, and others—has been well worked out by the Chemists of the Imperial Institute, and the results are published in *Bulletin* No. 41, of the Botanical Department of Trinidad. A recent issue of the *Bulletin*, for January 1905, contains a short article on the preparation of Castilloa rubber. It is stated by other authorities that the coagulation of rubber depends on the coagulation of the albuminoids contained in the latex. Two or three years ago I criticized that statement, and that criticism was adopted by the late Dr. Weber, then scientific adviser of the India Rubber Association, and it has now been proved that we can remove a large amount, if not all, of the albuminoids without injury to the rubber. With regard to tapping, that, as I have said before, may be regarded as being still in an experimental stage. It is believed that more latex may be obtained from a horizontal than a vertical cut. There is also the view held by Captain Short that an oblique cut also induces to a greater flow than a vertical cut. I do not see how an oblique cut made upwards instead of downwards can help the flow of rubber; but I have never tried it as yet, and it might be quite feasible.

The PRESIDENT: The point with regard to that is this: you want to have a rough cut in order to wound the edges of

the ducts. I have heard that with an upward cut you go against the grain more than with a downward cut. I do not know if that is true.

Mr. HART: Nor am I aware of that. I have here an instrument for tapping which I have had made here in Trinidad; it works very satisfactorily and with greater rapidity than the mallet and chisel. I have also here machines for cleaning and preparing the rubber, the working of which I shall be glad to explain to members of the Conference.

With regard to manure: I believe that anything that will tend to improve the growth of the trees can be usefully applied. Castilloa appears to grow almost anywhere and to thrive in different classes of soils. I am not prepared to state what are the constituents which suit it best, but it is found that almost any fairly good soil for cacao will also grow Castilloa. I am unable to give any reason for the increase in the flow of rubber from Hevea after frequent tappings, but I believe the fact to have been fairly established. As to the greater flow of latex from trees of the same size, I think that is accounted for chiefly by the position of the trees in the ground, and the amount of moisture in the particular tree. The difference, however, is in the flow of latex and not the yield of rubber; that is to say, there is a larger amount of water in the tree; but in our case the yield of rubber is found to be the same.

The Hon. WM. FAWCETT (Jamaica): Our experience in Jamaica differs from the experience in Trinidad in regard to shade. At Hope Gardens, which are in a dry district, and at Montego Bay, which is also a dry district, and in another district which has an average rainfall of 70 inches, we find that Castilloa does better without shade. Attempts have been made to grow it with shade, but they failed. Mr. Hart says that Castilloa will not grow in Trinidad without shade, but is it not strange that in Tobago, which is not very far from Trinidad, and where one should expect similar climatic conditions to prevail, there is a large number of Castilloa trees growing as shade for cacao and not requiring shade themselves, except for a short time in the early stage of their growth? Professor Cook, in a book lately published by the Department of Agriculture at Washington, has given his experience in Central America, and it is that Castilloa does better with shade than without. My experience is that after germination, Castilloa trees do not require any shade beyond that provided by themselves.

The Hon. B. HOWELL JONES (British Guiana): The experience in British Guiana is exactly as in Jamaica. Castilloa grows without shade. I have recently planted 200 young trees and have not planted any shade trees with them.

Dr. H. A. A. NICHOLLS (Dominica): With regard to one question brought up in the course of this discussion, I should like to sound a note of warning more particularly to the cacao planters of Trinidad. It is urged that Castilloa should be used as a shade for cacao. Assuming, for the sake of argument, that shade is necessary for cacao, the planters here possess in

Erythrina a shade tree which is not cropped and which, therefore, takes nothing from the soil, on the contrary it improves the soil by adding nitrogenous matter, and so will assist the cacao trees in producing crops. If, on the other hand, the planters follow the advice given them to-day and plant *Castilloa elastica* amongst their cacao trees, they will, later on, be getting two crops from the same soil. The yield here of dried cacao is said to be about 1½ lb. per tree; in the Northern Islands this would be considered a very small return. If rubber trees be planted amongst cacao in Trinidad it may be expected that the cacao return will be less, for the rubber will take away soil constituents of the cacao therefrom. It will be a case of robbing Peter to pay Paul.

Mr. W. R. Buttenshaw (Scientific Assistant on the staff of the Imperial Department of Agriculture): With a view to showing that considerable attention is being paid to the planting of rubber-yielding trees in the West Indies, if on a small scale, I have obtained from the various annual reports the following figures as to the distribution of rubber plants from some of the Botanic Stations and Botanical Gardens. I must mention that rubber trees have, no doubt, also been distributed from some of the other stations, but in those cases these trees are not specified:—

Dominica ...	1902-3	1,215	Funtumia plants, quantities of Funtumia seed, and 32 lb. of Castilloa seed.
„	1903-4	4,316	Funtumia plants, 2,480 Castilloa plants, 38 lb. of Castilloa seed, and quantities of Funtumia seed.
St. Lucia ...	1902-3	171	Castilloa plants.
Montserrat ...	1902-3	388	Funtumia plants and 181 of Castilloa.
„	1903-4	316	Funtumia plants and 11 of Castilloa.
Tobago ..	1903-4	644	rubber plants (kind not specified).
Jamaica ...	1903-4	2,640	miscellaneous rubber plants were distributed from Hope Gardens.
British Guiana	1903-4	1,500	Funtumia plants, 60 Castilloa, and a quantity of Castilloa seed.

The President: When I visited British Honduras in 1882 Mr. Reginald Ross was then establishing a cacao plantation, and I suggested whether he could not try Castilloa as a shade tree. The Castilloa is related to the bread-fruit tree, which is well known as a good shade tree for coffee. Mr. Ross followed my advice, and after a lapse of more than twenty years, Mr. Campbell, Superintendent of Agriculture in British Honduras, informs me that the cacao has done exceedingly well, and likewise the rubber trees. I believe that, where the soil is sufficiently rich, Castilloa trees might advantageously be grown among cacao trees. We cannot lay down any general rule with regard to this matter; we can only assert that in

some instances Castilloa trees have been used as shade for cacao without any injurious results. In Trinidad Mr. Hart is of opinion that these trees require shade, and we have the theoretical opinion of Dr. Nicholls that it is undesirable to plant rubber trees as shade for cacao because he thinks that possibly we may injure the cacao trees. We may leave the matter open for the present and continue our experiments, in the hope that a few years later we shall know more about it.

APPENDIX.

CASTILLOA AS A SHADE TREE FOR CACAO.

In the foregoing discussion the possibility of using *Castilloa elastica* as a shade tree in cacao plantations was brought forward. As bearing on this phase of the subject the following extracts from an article by Mons. P. Cibot, reproduced in the *Tropical Agriculturist* (February 1905), descriptive of cacao cultivation in Venezuela, are likely to be of interest:—

'I have recently had the opportunity in Venezuela of visiting one of the principal plantations which produce that cacao, so justly reputed, known as Caracas. I found opportunity there to study also a plantation of *Castilloa elastica* used as a shade tree.

'General Fonseca, installed in the fertile valley for some twenty years, has gradually acquired the greater part of the plantations laid out in it. He owns to-day thirteen plantations, producing a total of 480,000 lb. cacao in 1903-4.

'Going over General Fonseca's plantations, I could not but admire their beautiful appearance and the care taken with the irrigation of the whole property; but my attention was specially drawn to the plantation of *Castilloa elastica* mentioned above. In 1890, when they were only beginning to think of plantations of rubber trees in South America, General Fonseca was among the first to realize the value of giving as shade to cacao, in place of the trees formerly used and which served no purpose beyond that of screens, such a tree as Castilloa, able to furnish a valuable product. He imported 5,000 Castilloa seeds from Costa Rica; but these seeds, badly packed, lost their germinating powers, and only seventy seedlings could be raised. The young plants, after some months, were planted out in different parts of Las Monjas estate, amongst the cacao trees, which gave them favourable shade. These Castilloas developed admirably.

'In 1895 these first trees fruited; the seeds were carefully collected and planted in nurseries, and in 1895-6 about 8,000 plants were put out in places where shade was wanted for the cacao trees. These trees, aged eight to nine years now, are a beautiful sight; they have attained a height of 36 to 45 feet, and have an average circumference of 33 inches.

'At about four or five years the Castilloas easily outgrow the cacao trees and commence to give them a little shade. As they plant up Castilloas on the property, they kill out the

"Bucares," or other shade trees, ring-barking them with the axe at about a yard above the ground.

'The yield of Castilloa plantations is no longer to be doubted; the result obtained at Ocumare is a new proof, but the experiment made by General Fonseca is specially remarkable as it shows that the Castilloa can be grown among cacao trees without in any way harming their production. Indeed, at Ocumare they have noticed no diminution in the number of pods carried by the trees shaded by Castilloa, nor any change in the quality of the bean.'

In the same number of the *Tropical Agriculturist* (p. 529) the following extract is published from a letter from 'a well-known planter at Matale,' Ceylon, in which he sums up his experience in regard to Castilloa and cacao as follows:—

'I have very large Castilloas growing both along roads and also scattered through cacao, the latter of about fourteen years' growth showing no evidence of prejudicial influence from the Castilloas. My clearing of some 30 acres of Castilloa and cacao planted together six years ago so far supports the contention that these two products may be grown together.'

THE COCOA-NUT INDUSTRY OF TRINIDAD.

BY W. GREIG.

The important place this industry holds in the resources of Trinidad cannot be gauged directly by any official publication of trade statistics. Its products of nuts and oil are largely consumed in many different ways locally, and the industry being under no legislative restrictions, by which its products would be definitely known, it is somewhat difficult to estimate its importance.

On the basis of the East Indian immigrant's ration of oil and an East Indian population of 80,000, the Collector of Customs in 1902, estimated the local consumption of oil at 700,000 gallons, representing 35 to 40 millions of nuts. In the same year the exports of copra (414 tons) represented $2\frac{3}{4}$ millions of nuts; and oil (16,000 gallons) another million, making, together with the export of nuts, the produce of this industry equivalent to about 50 millions of nuts. The acreage returns of our Wardens for the same year, showing 14,000 acres under cocoa-nut cultivation, corroborate this estimate. I have presumed to check those figures and see no reason to alter them. The local consumption of oil may appear extravagant, but no account has been taken of the consumption of green nuts or of oil used for the purposes of lighting, cooking, and lubricating, by the general population.

The cultivation of cocoa-nuts is carried on principally in the Cedros district, which forms the extreme south-western point of Trinidad, and the coast between Galeota and Manzanilla points on the East Coast, where the plantations are

contiguous; but on our other coasts, with the exception of the north, there are many isolated plantations. The crops produced by the plantations range from 4½ millions down to a few thousand nuts, and on almost all of them there were, until recently, some facilities for making oil.

Previous to ten years ago some even of the largest plantations were dependent on the nut market only for the disposal of their produce; but since then all the largest have been equipped with copra-drying houses which enable them to turn a perishable product into one that can be safely stored, and this gives them a choice of markets. More recently a further advance has been made by drying copra artificially by hot air, and by this method a better quality can be made irrespective of weather conditions. Curiously, our industry has omitted one step in its evolution, that of drying copra over open fires of husks and shells, as is done in the east, even now, on a large scale, and this omission has somewhat retarded our advance toward artificial drying by hot air. In European markets the highest-priced copra is described as 'sun-dried' and on that account, even to-day in Trinidad, many think that artificially dried copra realizes a lower price, whereas such is not the case, unless it has been discoloured during the process. The term 'sun-dried' in regard to copra indicates a quality or grade only and is applied to the best white copra to distinguish it from the brown, smoked copra, which has been dried over an open fire.

Although the manufacture of oil from cocoa-nuts has been general for very many years past, it has only assumed the position of a staple industry since the making of copra became general. Previous to that date the process was crude, cumbersome, and wasteful, and required much labour in proportion to the output, and being made only by small producers the individual output was small, although, in the aggregate, it amounted to a large quantity. Since copra has been produced generally, however, there has been a change, as it was possible to manufacture oil from copra here as economically and as well as in Europe or America. The result has been that in recent years almost every plantation of any consequence has been equipped with hydraulic presses for the expression of oil from copra, and as such plantations are able to pay more for the nuts of their small neighbours than they could realize by turning them into oil by the old crude method, this process is gradually dying out, to the advantage of the industry as a whole.

Thus equipped, the large plantations have a choice of the three markets, nuts, copra, and oil, and at the present time take advantage of all by selling their large nuts and making copra of the small ones, the disposal of the latter depending upon the relative values of copra and oil. Each plantation should have a simple table calculated from its cost of production and results, showing the relative values of nuts, copra, and oil, which would serve as a guide in the disposal of its products.

Having thus briefly described the development of our present cocoa-nut industry during recent years, I will now

describe the methods of working as compared with those elsewhere.

The usual practice in planting cocoa-nuts here is to clear and burn the land, which is then lined and staked, the stakes being 25 feet apart; holes are dug at each stake into which the seed-nut is placed and barely covered with earth. In some cases the seed-nuts are imported nuts of known quality, and in others they are selected from heaps on the plantation, but these are exceptional cases and I do not think it is too much to say that sufficient attention is not paid to the selection of seed-nuts.

In Ceylon seed-nuts are selected from trees of strong and robust growth, and of middle age, producing large nuts with thick and heavy kernels; the nuts are allowed to mature on the tree and when picked are lowered by hand and not thrown down as is usual here. Nurseries are prepared in good land, in or near to the field to be planted, by trenching 18 inches deep and dividing into beds 3 feet wide. The seed-nuts are laid side by side on the beds, and the spaces between filled in with earth, after which the beds are covered with grass or straw to the depth of 3 inches, and water is applied frequently, especially during dry weather. After six months the young plants are removed to other nurseries where they are planted 3 feet apart and where high cultivation is concentrated upon them. When the plants are from two and a half to three years of age, the whole field is cleared, lined, and holed, and the plants from the nurseries are transplanted to the positions they will permanently occupy. All nuts which are slow in springing in the first nursery are rejected and not replanted into the second, and any plants in the second nursery which do not show vigorous growth are also rejected; so this method gives opportunities for an exceptionally good selection of seed and it is claimed that fields planted in this way are most regular and yield the largest number of nuts per acre. The saving effected by not having to keep the whole field clean for the three years during which the plants are growing in the nurseries, is claimed more than to cover the cost of the nurseries and transplanting three-year-old plants.

After planting, the young trees should be kept free from grass and weeds until they come into bearing; here it is usual to keep only such land as is occupied by the young trees clean, and this practice has its advantages as it keeps the unoccupied land under cover and economizes labour. Fields come into general bearing here between the ages of from twelve to twenty years, depending upon the quality of the land and mode of cultivation, but from the fact that many individual trees begin to bear at eight years of age it may be inferred that, with a more careful selection of seed and a more liberal system of cultivation, this long period might be considerably reduced.

From the time crops are reaped there is a constant drain of plant food from the land, which must be made good somehow, or the ultimately inevitable exhaustion of this plant food must bring about failure of crops. This exhaustion depends upon

what part of the produce is removed and not returned to the land, as the husk, shell, oil, and meal, contain the more important plant foods of the soil in different quantities and proportions. Thus, if only oil is shipped from the plantation and the meal and ashes of the husks and shells used as fuel are returned to the land, the loss will be of little consequence, especially if the meal is fed to stock whose manure is utilized. If, on the other hand, the unpeeled nut is shipped the loss is great.

Appended is an analysis of the different parts of the cocoa-nut and a table showing the more important ingredients of the soil removed by the husk, shell, kernel, and milk of 1,000 nuts. From this it will be seen that 1,000 husked or peeled nuts remove from the soil 5·22 lb. of potash, 4·95 lb. of nitrogen, 1·60 lb. of phosphoric acid, 1·18 lb. of sodium chloride, and 0·48 lb. of lime, which suggests kanite, basic slag meal, and green soiling with a leguminous plant as a cheap and effective system of maintaining the fertility of a cocoa-nut plantation.

Little tillage or manuring has been done hitherto on Trinidad plantations, which is probably accounted for by the fertility and suitability of our soils at present under cocoa-nuts, and the shortness of time the best plantations and those under most intelligent management have been in cultivation; but one has but to compare them with some of the older plantations to see what they may come to if this is neglected.

The cocoa-nut palm bears all the year, the flowers and mature nuts being seen on the same palm at all times, but, as a matter of convenience, generally only two pickings per year are made, when only the mature nuts are supposed to be thrown down. In Sumatra the Malays have trained baboons to this work so effectively that only fully matured nuts are picked, but in Trinidad our more intelligent picker knows that the more nuts per tree he picks the fewer will be the number of trees he will have to climb, with the result that even under constant supervision a considerable number of immature nuts are picked. As such nuts are inferior for copra or oil making, and if shipped depreciate the value of our nuts in the markets, this has become a serious problem and one which the highest authorities in Trinidad think can be solved only by allowing the trees to drop their nuts, and employing men only to free the crowns of the trees once annually of dry spathes, stalks leaves, and ants' nests.

The nuts having been picked, they are collected into convenient heaps where they are either opened and the kernel removed, when copra or oil is to be made, or husked and selected, if nuts are to be shipped, tho kernels being conveyed to the drying house or the nuts to the shipping place.

The copra-drying house is similar to the ordinary cacao-drying house, and the only manipulation required in drying copra is frequently to stir and turn over the pieces so that all parts may be exposed to the drying influence of the sun and wind. From five to ten days may be required to dry copra thoroughly, the time depending upon the sunshine and

atmospheric conditions. The problem of artificially drying copra is simple compared with that of drying cacao, but from the design of some of the artificial drying houses one sees in Trinidad it is apparent that it has been misunderstood by many. Heat is of secondary importance, being only useful in enabling the large volume of dry air, which is essential, to absorb more moisture than it otherwise would in its passage through the copra; whereas, usually, heat takes the first place and ventilation or the means of circulating dry air and removing the moist air has been omitted or given a secondary place.

The process of manufacturing oil from copra is simple, it being necessary only to disintegrate the copra so as to rupture the oil cells, the meal being then placed in bags and subjected to a pressure of about 2 tons to the square inch in hydraulic presses until the flow of oil ceases. A high extraction depends upon the degree of fineness to which the copra can be reduced, or in other words, the complete rupture of all oil cells. From a plantation's own copra an extraction of 156 gallons of oil per ton of copra may be expected and from ordinary commercial copra a fair average extraction would be 153 gallons per ton, and in most plantation oil factories the value of the residual meal as a stock food covers the cost of manufacturing oil.

As a very large proportion of the oil manufactured is sold locally, where the demand does not call for a high quality, little attention has been given to refining, simple filtration or subsiding only being resorted to: but the time will come when higher prices will be obtained for oil of high quality and it would be well for cocoa-nut planters to be prepared to take advantage of them. High-class oil can be made cheaply by the use of Fuller's earth in the filtration of oil made from *good* copra, but good copra can be made with certainty only by artificial drying, and although sun-drying houses will always be useful, an artificial drier can always be run economically as an adjunct to an oil factory, and every factory should be equipped with one.

There are good reasons why many of the items exported under the head 'cocoa-nuts' from other cocoa-nut-producing countries cannot be so exported here: for example, dessicated nut, the manufacture of which requires much cheap labour; poonac or cocoa-nut meal, which is locally consumed; arrack or cocoa-nut toddy, about which the less said the better, owing to its pernicious effects: but why no use has been made of the husk to produce fibre, which is shipped from Ceylon under five heads, it is hard to say. The necessary machinery is simple, as is also that for converting the fibre into yarn, rope, and mats.

The conclusions to be drawn from this sketch of the cocoa-nut industry of Trinidad are that, although much progress has been made in the past and all credit is due to those who have succeeded in bringing it to its present stable and prosperous condition, yet it is well occasionally to compare results with those who have been working longer and on a larger scale, and this will show that there are still many improvements which can be adopted by the Trinidad cocoa-nut planter.

DR. BACHOFEU'S ANALYSIS OF THE COCOA-NUT.

	Husk.	Shell.	Kernel	Milk.
Total weight in pounds	2·702	0·546	0·875	0·593
do. per cent.	57·28	11·59	18·54	12·58
{Moisture per cent.	65·56	15·20	52·80	...
{Dry matter per cent.*	34·44	84·80	47·20	..
Pure ash per cent.	1 63	0·29	0·79	0·38
Containing :—				
Silica, SiO_2	8·22	4·64	1·31	2·95
Oxide of iron and alumina Fe_2O_3, Al_2O_3	0·54	1·39	0·59	Trace.
Lime, CaO	4·14	6·26	3·10	7·43
Magnesia, MgO	2 19	1·32	1·08	3·97
Potash, K_2O†	30·71	45·01	45·84	8·62
Soda, Na_2O	3·19	15·42	...	...
Potassium chloride, KCl†	...	...	13·04	41·09
Sodium chloride, NaCl ...	45 95	15·56	5·01	26·32
Phosphoric acid, P_2O_5 ...	1·92	4·64	20·33	5·68
Sulphuric acid, SO_3 ..	3·13	5·75	8·79	3 94
	100·00	99·99	99·99	100·00
*Containing nitrogen, N . .	0·137	0·100	0·504	.
†Containing total potash, K_2O	30·71	45·01	54·05	34·54

Thus of the more important ingredients of the soil 1,000 nuts remove the following :—

In pounds.	Husk.	Shell.	Kernel.	Milk.	Total pounds.
Nitrogen, N	3·7017	0·5460	4·4100	...	8·6577
Phosphoric acid, P_2O_5	0·8456	0·0785	1·4053	0·1279	2·4523
Potash, K_2O	13·5255	0·7127	3·7362	0·7783	18·7527
Lime, CaO	1·8234	0·0991	0·2143	0·1674	2·3042
Sodium chloride, NaCl	20·2875	0·2464	0·3563	0·5431	21·4233

APPENDIX.

Composition of Cocoa-nut Kernels and Cocoa-nut Meal.

Constituents.	Cocoa-nut kernel. Per cent.	Cocoa-nut meal or cake. Per cent.
Water	46·6	10·3
Ash	1·0	5·9
Protein	5 5	19 7
Crude fibre	2 9	14·4
Nitrogen-free extract ..	8 1	38 7
Oil	35·9	11 0

Feeding Value of Cocoa-nut Meal.

Henry makes the following remarks, in his *Feeds and Feeding*, on the feeding value of cocoa-nut meal :—

'The residue in the manufacture of cocoa-nut oil is known as cocoa-nut or cocoa meal. It is used quite extensively by dairymen in the vicinity of San Francisco. Cocoa-nut meal has the reputation of producing fine butter of considerable firmness, and is therefore recommended for summer feeding to dairy cows. It may be used with advantage for swine and sheep, serving also as a partial substitute for oats with working horses.

'The French war department investigated the value of cocoa-nut meal for horses. Ten army horses were fed on cocoa-nut meal for four weeks in place of an equal quantity of oats in the ordinary ration. Five horses receiving the ordinary oat ration were included in the experiment and given the same work as the others. They were exercised only a little during the first period, January 12 to 30, viz., 8 to 9 miles. They were worked harder for the next two weeks, January 31 to February 12, viz., 15 to 17·5 miles. Weighings were taken before and after the change was made with averages as follows :—

	Cocoa-nut meal rations, pounds.	Ordinary ration, pounds.
January 12	963·4	996·4
January 31	977·5	992·9
February 12	970·9	983·2

'The results proved that cocoa-nut meal was equal and even superior to the same weight of oats. According to French prices of feeding stuffs, a substitution as in the above experiment would bring about a reduction in the cost of keeping army horses of $10·00 each per year.'

The digestible nutrients and fertilizing constituents are given by Henry as follows:—

Dry matter in 100 lb.	...	89·7 lb.
Digestible nutrients in 100 lb.	Protein ...	15·6 „
	Carbohydrates ...	38·3 „
	Fat ...	10·5 „
Fertilizing constituents in 100 lb.	Nitrogen ...	3·3 „
	Phosphoric acid ...	1·6 „
	Potash ...	2·4 „

ANTHRAX.

BY HENRY A. BALLOU, B.Sc,

Entomologist on the staff of the Imperial Department of Agriculture.

The appearance of anthrax among the cattle of certain parts of the West Indies during the past few years has resulted in a keen interest in this disease in its various aspects.

The object of this paper is to state briefly the nature of the disease, the symptoms of its various forms, its communicability to man, its history, especially in the West Indies, and the means taken for its prevention and suppression.

Anthrax has been known by a number of names such as Charbon, Carbuncle, Malignant Pustule, Splenic Fever, and Wool-sorters' disease. It may be defined as a specific disease caused by the anthrax bacillus (*Bacillus anthracis*) which is a microscopic organism of a cylindrical, rod-like shape, with a length of from $\frac{1}{5000}$ to $\frac{1}{2500}$ inch, and a diameter of $\frac{1}{25000}$ inch.

These rod-like bodies have the power of indefinite multiplication, as have all bacteria. In the body of an infected animal, these rods multiply by division, each full-grown individual dividing into two. During this growth and increase in numbers, poisonous substances are produced which result in the death of the animal. Outside the body, however, they multiply in a different way: oval-shaped spores are formed inside the rod-like bacilli. The bacilli are quite easily destroyed by the ordinary germicides, but the spores are very resistant. They remain alive and capable of germination for years even though subjected to extreme dryness, and are very difficult to destroy by any methods of disinfection.

Anthrax is of almost world-wide distribution. It is known to occur in Europe, Asia, Africa, Australia, North and South

America. In any country, however, certain restricted areas are more likely to give rise to outbreaks of anthrax than other parts, and this is due to the fact that the soil and climatic conditions of such areas are more favourable to the spores of the disease. Such localities, once infected, are frequent sources of infection. It has been found that black, loose, humus or peaty soils, as well as swampy districts, containing permanent pools of stagnant water, are among the most favourable to anthrax, and low lands subject to floods and inundations, which are followed by hot weather, also frequently give rise to serious outbreaks. Another source of infection is to be found in the bodies of animals that have died from anthrax. In such bodies the anthrax bacillus is present in enormous numbers, and if any blood or other body fluids are exposed to the air, numerous spores are formed. On this account the bodies of anthrax animals should be buried at once and without being opened. It will readily be seen that if carcasses of anthrax animals are not properly disposed of, the disease may become thoroughly established and the spot in which they died may prove a permanent source of infection.

Animals are infected by anthrax in one of three ways, viz., by means of spores taken into the body with food or water, giving rise to intestinal anthrax; by means of spores in the air, taken in in breathing, giving rise to anthrax in the lungs; and by direct inoculation through the skin.

The first of these is the most common way for animals to contract the disease. This may come about from grazing in fields or pastures where anthrax animals have died or have been buried, or where there is drainage from such places.

Many different animals are subject to anthrax. Cattle and sheep are most susceptible to this disease and it frequently occurs in horses and mules. A number of wild animals and poultry are also sometimes attacked. Carnivorous animals are more immune than the herbivorous, and the rat is said to be almost completely immune. Newly imported exotic animals are more susceptible than acclimated ones. A first infection, from which the subject recovers, confers a certain degree of immunity. It is also communicable to man, and frequently results fatally.

Symptoms.—The diagnosis of anthrax should always be referred to a medical or veterinary officer, but certain conditions indicating the disease should be known, and any animals exhibiting such conditions or symptoms should at once be isolated and carefully watched until the arrival of an expert.

Of internal anthrax there are three forms, distinguished, according to the course of the disease, as (1) hyper-acute, (2) acute, and (3) sub-acute.

The hyper-acute forms are the most rapid in their action, and are always fatal. When attacked by this form of disease 'the animals are affected suddenly, stagger, and fall; the nose, anus, and mouth give exit to a bloody liquid. The patients die in convulsions within a certain lapse of time, which varies from a few minutes to one hour at most. They are often found dead in the morning on opening the stable; they sometimes die

during work, on pastures, or while taking their meals. Such cases usually occur at the beginning of an outbreak.'

The acute forms are a little less rapid, the duration being two to twelve hours generally, with twenty-four hours as a maximum. There is acute fever, accompanied with stamping, bellowing (in cattle), staggering gait, convulsions, death. In some cases there are bloody emissions and laboured breathing; in others the symptoms are remittent.

The sub-acute forms are similar to the acute, but are even less rapid, the duration is generally twenty-four hours to forty-eight hours with a maximum of five to seven days. The febrile conditions, chills, etc, are more marked, and colics frequently accompany other symptoms. The external forms of anthrax, commonly called malignant pustule, carbuncle, etc., are less rapid than most cases of internal anthrax, the duration being from three to seven days.

Treatment.—From the nature of the disease curative treatment is rarely successful; in fact the first animals attacked generally die before it is realized that anything is wrong with them. Preventive treatment, however, has been proved of great value in checking the spread of an outbreak, and in preventing the occurrence of epidemics.

From what has already been said of the manner of infection, it will be seen that the following recommendations should be carefully carried out. Suspected animals should be isolated, and anthrax carcasses at once buried or cremated; the destruction of all litter, etc., in the stables where anthrax animals have died, and the disinfection of stables are absolutely necessary.

Animals suspected of having died of anthrax should not be skinned or cut open. All natural orifices should be plugged immediately with tow or cotton wool soaked in strong corrosive sublimate or carbolic acid solutions to prevent the escape of any blood or other matter that might carry the disease. For burial of such carcasses a place should be chosen where a deep grave can be dug, and where the soil water will not drain into any well or stream, the water of which is used for drinking purposes. The carcass should be covered with quick-lime. The place of burial should, however, be as near the spot where the animal died as possible.

Pastures and grazing lands known to be infested with anthrax should be fenced off so that animals may not have access to them. Swamp lands should be drained if possible, and water running through any infested area should not be used for drinking purposes.

The greatest cleanliness should be observed in regard to the care of animals suffering from cutaneous anthrax. All utensils used on such animals should be thoroughly disinfected, and harness, headstalls, etc., that have been used on anthrax animals should not be used on healthy ones. The disease is rarely communicated directly from anthrax animals to healthy animals, but generally by means of the agencies mentioned—infested pastures, and stables, utensils and harness, and the

bites of insects. Consequently, every precaution taken to prevent the communication of the disease by these means will be a step toward checking its spread.

Preventive inoculation.—Preventive inoculation consists in producing a mild form of the disease by means of a pure culture of the disease organism. The cultures are developed in a temperature much higher than that normal for the organism, with the result that it is much less virulent than the same organism produced under normal conditions, and the disease resulting from its use is a mild form and not likely to result fatally. Following this inoculation, animals possess a certain degree of immunity to the normal type of the disease.

The use of anthrax vaccine, as these cultures are called, has been attended with varying degrees of success in different countries. In the West Indies and British Guiana, as well as some other places, however, the results have been very encouraging, and the practice is being vigourously carried on in those localities where anthrax has appeared. The anthrax vaccine used in the West Indies is obtained from the Liverpool School of Tropical Medicine. Two fluids are used: the weaker first, and the stronger about twelve days later. The weaker fluid is produced at a much higher temperature than the stronger, the latter more nearly approaching the condition of the bacillus produced under normal conditions.

The vaccines are injected by means of a hypodermic syringe into the skin at the side of the neck.

This account deals especially with anthrax in cattle and sheep, but horses and mules suffer from attacks of the disease, and the preventive treatment already recommended applies also in their case. Infested pastures should be avoided, and in case of an outbreak, preventive inoculation may be practised in the same way as with cattle and sheep.

Anthrax also occurs in man as intestinal anthrax resulting from eating the flesh of anthrax animals; as wool-sorters' disease, or anthrax of the lungs, contracted in handling wool or hides which contain the anthrax spores; and as carbuncle or malignant pustule, resulting from contact with infected material. Malignant pustule most frequently results from the inoculation of wounds or scratches in the skin by contact with harness or stable implements used on anthrax animals or in skinning animals that have died from anthrax.

Cattle should be inoculated with the anthrax vaccine immediately on the appearance of the disease on any estate, but it is recommended by the Bureau of Animal Industry of the U. S. Department of Agriculture that the work of inoculation should be performed only by trained veterinarians, and that it should not be used in regions where anthrax is not known to have occurred.

'It is very important to call attention to the possibility of distributing anthrax by this method of protective inoculation, since the bacilli themselves are present in the culture liquid. It is true that they have been modified and weakened by the process adopted by Pasteur, but it is not impossible that such

modified virus may regain its original virulence after it has been scattered broadcast by the inoculation of large herds. No vaccination should, therefore, be permitted in localities free from anthrax. It is also obviously unsafe to have such vaccine injected by a layman; instead, it should be handled only by a competent veterinarian.

'Anthrax is an entirely different disease from blackleg, and therefore blackleg vaccine does not act as a preventive against anthrax.'

OCCURRENCE IN THE WEST INDIES.

There was an outbreak of anthrax in Barbados about 1891, which caused the death of many estate animals in St. Joseph's parish. In 1903 one sporadic case occurred in the parish of Christ Church of an ox found dead in the pen. No other case followed.

It is reported that some years ago a girl died in Barbados of malignant pustule, induced by the bite of a gad fly that had access to an anthrax animal.

In the Report of the Surgeon General in British Guiana for 1903-4 it is stated :—

'There has only been one sporadic case of anthrax throughout the whole year. This is striking testimony for the inoculation theory, the soundness of which has been demonstrated twenty years ago. Being new, some of the inhabitants of this colony were at first reluctant to adopt it. I am not over anxious to adopt new methods, and wait until their usefulness has been well established before urging their acceptance here. Inoculation against anthrax has reduced the mortality in France from 20 per cent. to ¼ per cent., which, I think, is of itself sufficient proof of its reliability.

'Anthrax is a most serious disease. Not only does it affect the lower animals, usually fatally, but it is also capable of communication to the human subject. Therefore, any one who knows, or has reason to suspect, that anthrax is on his estate or premises should not think twice about reporting it. If he fails to notify the presence of the disease, it is not too much to say that he may be responsible for the loss of many human lives. It is too grave a matter to be trifled with, and some idea of its virulence can be formed by stating that in the year 1617 over 60,000 persons died in the vicinity of Naples from consuming the flesh of animals affected by this complaint.'

An outbreak of anthrax occurred in Berbice in November 1904.

The occurrence of this disease in St. Vincent is fully dealt with in the following paper by Dr. Branch.

ANTHRAX IN ST. VINCENT.

BY C. W. BRANCH, M.B., C.M. (EDIN.).

In 1899 anthrax became so prevalent among stock on the estates of Mr. C. J. Simmons, Belvidere, Brighton, and Diamond, that Mr. Thompson, then Administrator, imported some of Pasteur's vaccine and gave it to Mr. Conrad Simmons together with some Board of Agriculture publications.

On August 14 of that year, Mr. Conrad Simmons writes that he had put into force the recommendations of the Board of Agriculture, and that there was no more disease on his father's estates. He does not, however, mention whether he tried the vaccine. During the same year Calder estate lost several head from anthrax, and Mr. Smith at Argyle had difficulty in taking off his crop having lost nearly all his working cattle.

On May 31, 1902, a case of human infection with anthrax was admitted to hospital from Glen. On June 25, another from Arnos Vale who died the same day. On July 28, a woman from Argyle estate who died next day. On August 21, a case was admitted from Belair estate. On August 30, a child from Cane Hall estate. The father of this patient had lost every head of stock he owned—a donkey, a calf, and seven goats, some of which died at his door step. On September 30, another case was admitted from Arnos Vale.

During several months animals belonging to estates and to labourers had been dying in many places. Messrs. J. H. Hazell, Sons, & Co. had lost stock at Calder. After the volcanic eruption they sent thirty head of cattle for pasturage to Mustique, an island used for raising horses, and anthrax appeared there. The loss amounted to twelve cattle, fifteen horses, a mule, and twelve sheep. By limiting the stock to a distant part of the island, and by careful disposal of the carcasses the epidemic was stayed, and the disease has not, I believe returned.

Mr. James Simmons in town received a rabbit as a present, which died a few days after in his stable. Within a month two horses died of anthrax in the stable, which had then to be thoroughly disinfected.

The epidemic was soon so well recognized that a panic occurred in Kingstown, and very many persons hearing of fatal cases of human infection celebrated a hygienic Lent. The butchers advertised in the papers that their animals were bought from the Leeward District where there was no anthrax.

The matter having come to the notice of Sir R. Llewelyn, the Governor, he asked for reports, and the Administrator, Mr. Cameron, consulted several gentlemen. Mr. H. Powell, of the Agricultural Department, writing on October 13, 1902, says he had been aware of anthrax in the colony for ten or twelve years. He placed the loss at Belvidere and Brighton in 1899 at thirty mules. In April 1901, he says, Argyle lost twenty cattle, and Calder suffered severely also.

Mr. Conrad Simmons, writing on October 13, says he had known of anthrax in the colony about ten years, but believes it may have been present longer. He had noticed there was an almost regular annual recurrence between May and October in the same localities.

Mr. P. Huggins informed me he had lost eighteen out of twenty-seven head of stock in 1900.

On October 12, in reply to Mr. Cameron, I mentioned the occurrence of several cases of human infection, stated my conviction as to the nature of the disease, and advised that notices should be issued warning the public and instructing stock owners how to deal with the infected carcasses. I advised that the skinning of diseased carcasses and the sale of their meat should be prohibited, and that steps should be taken to prevent the exportation of stock.

Mr. Cameron by telegram reported the prevalence of anthrax to Sir Daniel Morris and to the Governors of the neighbouring colonies. St. Vincent was thereupon quarantined for anthrax, and trade in stock was in consequence checked.

Mr. Cameron prepared a very practical and useful leaflet which he issued on October 20, 1902, (reprinted at end of this paper), and the Leaflet No. 28, 1893, (revised November 1902) of the British Board of Agriculture on Anthrax was reprinted in the Government *Gazette.*

On November 6, 1902, I submitted a report to the Government with recommendations. I noted the steady spread of the epidemic towards Kingstown, and reported three instances where diseased meat had been hawked in the town for sale. The recommendations were :—

1. For the town :—

That it should be forbidden to hawk meat in the streets or expose it for sale except at the stalls of the licensed butchers.

That animals intended for slaughter should be kept under observation for four days, and that all meat should be inspected at the slaughter house.

2. For the whole colony :—

That the sale of meat of animals dying by accident or disease be strictly prohibited.

That the flaying of animals except those regularly slaughtered for food be prohibited.

3. That any anthrax order should apply to cattle, horses, donkeys, mules, sheep, goats, hogs, and even rabbits.

On November 28, 1902, I again reported the progress of events, and the Government took steps to obtain a conviction for the sale of diseased meat in the town. But the existing laws proved inadequate to meet the case.

On January 23, 1903, in reply to the Governor, I reported no case of human anthrax since the death on December 20, 1902, of a child not infected from an animal. The father

of this patient was the labourer mentioned above. Four of his children were infected during the year, of whom two died.

I advised that quarantine might safely be lifted. At the end of March and beginning of April the various colonies removed the quarantine, the Government of St. Vincent having, I believe, undertaken to notify the colonies of any appreciable outbreak of the disease.

During 1902, sixteen cases of human anthrax were treated by me, of whom three died. I was informed of other cases and know of one other death from this disease.

Following on the cases I have already enumerated, there were on October 15, three infected from one animal at Dorsetshire Hill.

October 20, one at Cane Hall.

November 3, one at Frenches.

November 4, one in Kingstown.

November 10, one at Cane Hall.

November 23, one at Lowmans on the other side of Kingstown.

December 1, one at Cane Hall Mountain.

December 17, one at Cane Hall Mountain.

In 1903, three persons were infected on June 25, at Belair estate. Later a woman was attended from Edinburgh but no note was kept of the date. On December 21, one was infected at Montrose estate in the Kingstown Valley.

In 1904, January 12, a case was infected at Sion Hill. April 9, one at Dorsetshire Hill. August 25, one at Paul Over in the Kingstown Valley.

At the risk of being tedious I have recounted at some length the history of the subject and the details of the cases of human infection. My object has been to show that anthrax, starting from a centre at Belvidere or Argyle, has steadily, and at one time rapidly, spread over the whole south of the island and has passed Kingstown on its way up the Leeward coast. One case has been mentioned of human infection at Lowmans, and I have had evidence of animal disease at Ottley Hall, both on the leeward side of the town. Of the Windward district north of Argyle I have no evidence, that region being out of my own observation. Dr. Austin, in 1902, told me of a case of human anthrax in Mesopotamia, and Dr. Leonard in 1903 reported that he had observed no anthrax on the Windward side.

Some apology is due for dealing so much with human disease before an Agricultural Conference. But most of the attention drawn to the St. Vincent anthrax has been through my own observations and reports; and, except when an estate has an outbreak among its stock, the only opportunity available for noting the occurrence of animal anthrax is the occasional accident of a person being infected.

Anthrax does not commonly cause a sensational loss, as does sheep-rot; but the persistence of the infection produces a steady and serious drain on the resources of an agricultural

community. What the loss in St. Vincent has been there is no means of ascertaining. From the frequency of human infection and the width of the area affected, it can safely be inferred that it was large in 1902.

A pasture or spot may remain infectious for several years; recent experiment has proved that anthrax bacilli continue active in clean water for more than two years; no steps are taken in St. Vincent to prevent further infection of localities, except by a few of the larger stock-owners. Consequently, the island may be considered to have anthrax firmly established for an indefinite future, and the next considerable outbreak will result in another rapid extension of the infected area.

No attempt has been made in this paper to prove that it is really anthrax that prevails in St. Vincent. Stock-owners there have no doubt of it. The history of the epidemic, the clinical features of the disease in animals and men, and the presence of bacillus in the human lesions identical with that of anthrax, as one has known it in the laboratory, combine to settle the diagnosis.

Mr. Miller, the Government Veterinarian of Trinidad, on February 7, 1903, wrote to his Government with reference to the St. Vincent disease:

'There is no evidence before me to justify the opinion that the cattle disease is anthrax. Anthrax develops very quickly, and the animal is dead in twenty-four hours. The flesh turns black and putrifies in a few hours so that it is impossible that any one would eat it.'

I do not think experience bears out this opinion. People not only can, but in St Vincent regularly do, eat the flesh of anthrax carcasses, as people have done also in other countries.

Under the pretext or belief that an animal has died by hanging or of a fall, or even with the full knowledge that death was due to disease, the labourers cut up and sell the meat. Even on estates, whenever an animal died, the flesh was sold to the labourers, and I believe on some estates this disgusting economy still obtains. It is only the thorough cooking usual among negroes that protects them from intestinal anthrax.

The subject has been brought up at this Conference in the hope that some practical suggestions may arise out of a discussion either here or in the agricultural papers.

Legislation on the lines, say, of the Anthrax Order of 1899, made under the Diseases of Animals Act, is inapplicable to the conditions in a West Indian colony.

It must be borne in mind that the chief means of the spread of anthrax is the contamination of new spots with the blood or discharges of dead animals. Animals, instead of being buried, are cut up for the sake of the meat. Were the carcasses properly dealt with, the disease would in time diminish.

Practically the only measures one can think of are:—

(1) The education of public opinion as to the eating

of unsound meat, and the attention of the primary schools may be directed towards this.

(2) Stringent prohibition of the flaying of any animals except such as are regularly slaughtered for food.

(3) Dissemination of information about the disease by means of agricultural instruction in the schools, and the distribution of leaflets periodically. The uneducated have a vast respect for the printed word.

Leaflet issued by his Honour the Administrator at St. Vincent, October 20, 1902.

A disease among cattle has appeared in St. Vincent during the rainy season for some years past, more particularly in the neighbourhood of the Mesopotamia Valley, Calder, Brighton, etc., from which many head of stock have perished,

This year the disease has been rather wider spread than usual and has been extended to the island of Mustique, in consequence of cattle from St. Vincent having been removed there.

The disease in question is known as anthrax or splenic fever, and in addition to its being very fatal to cattle, it is also highly dangerous to human beings, who can contract it by handling the dead animals. Several cases of anthrax have already been treated at the Colonial Hospital.

Animals which are suspected to have died of this disease should on no account be skinned or cut open in any way, but the body, in its skin, should, whenever possible, be carted at once to the sea, or if that is not possible, buried *deep* in the least frequented part of the pasture and away from any water or dwelling-house, and lime should be thrown on the body.

The flesh of such animals should never on any account be eaten.

All dung or droppings from suspected sick animals, or animals which have died should be carefully gathered up and destroyed by fire at some place where other animals do not have access.

Where an animal is seen to be sick with the symptoms of anthrax, it should at once be separated from the rest of the herd and allowed to die. It should not be cut or bled in any way. The other animals should be moved away at once to another pasture and kept separate, and carefully watched for ten days, when, if they show no signs of sickness, they may be considered healthy.

All sheds, stables, and buildings where a diseased animal has died or has been kept should be cleansed and disinfected as follows :—

Fresh lime should be thoroughly sprinkled about the place, which should then be swept, and all dung, trash, and anything else the animal has been in contact with, should be effectually removed.

The place should then be lime-washed, a pint of carbolic acid being used to a gallon of lime-wash.

Owners of stock are urgently requested to give attention to these precautions.

(Sgd.) EDWARD J. CAMERON,
Administrator.

Government Office,
October 20, 1902.

DISCUSSION.

Dr. H. A. A. NICHOLLS (Dominica): It appears that anthrax exists in several of the West Indian Colonies, and unless proper precautionary measures be taken it will become prevalent in other colonies which are now free from it. The spores of the anthrax bacillus are very resistant and their virility exists for a considerable period. It is quite possible that, in unconsidered ways, infection might be carried from one colony to another. Thirty years ago a disease broke out in some of the midland towns in England, where one of the chief industries was the manufacture of materials from the fleece of sheep brought principally from Asia Minor. The medical men were somewhat puzzled at first by the peculiar symptoms of what was a new disease to them, and which was called the wool-sorter's disease. It was, however, soon found out to be anthrax, or malignant pustule, and the people who were engaged in sorting the wool had inhaled the spores and so become infected. This disease manifests itself in human beings in two forms—an external, of which the malignant pustule is the type, and an internal form, affecting within the organs of respiration or digestion. The question of anthrax in animals attracted a great deal of attention when the great Pasteur directed the power of his wonderful mind to the discovery of a method of preventing the ravages of this disease amongst domestic animals, and eventually he succeeded in producing a vaccine by the use of which animals might be made immune. We have heard in one of the papers read to-day, that that vaccine was imported into St. Vincent, but, unhappily, we are also told that there are no means of finding out what resulted from it: had we the full particulars concerning the application and effect in one of these West Indian Colonies of this vaccine, it would have been of great interest and use, for its success would have been a splendid object-lesson. It has been pointed out that there is great danger of non-infected islands becoming infected by the importation of animals from infected places, and I think steps should be taken very soon after this Conference rises to bring to the notice of the different Governments the necessity for taking precautionary measures before they have the disease in their midst. Not only are horses and cattle susceptible, but all the rodents, herbivora, and some of the young of carnivora are liable to be infected, besides which the disease is capable of being communicated to man. The disease, too, is insidious. An animal may go to a stable at night apparently well and next morning it may be found dead of anthrax. It appears from what has been said that some of these islands are absolutely unprotected, and I suggest that the President of this Con-

ference should represent to the Governments concerned the necessity for providing measures against the introduction of the disease. It is suggested in Dr. Branch's paper that animals dying of anthrax should be deeply buried, or towed out to sea, but it appears to me that the better and the safer way of disposing of the carcass of the animal, in certain cases, is to destroy it by fire. If, for instance, an animal dies of anthrax in the field, the best course is to burn it on the spot, which can easily be done with wood, brush, and kerosene oil. In this way you will entirely get rid of the chance of infection. Most of the cases of anthrax in human beings have been found to result from infection whilst flaying the animals or whilst transporting them from the place where they have died to where they have been buried; but if the animal be burnt where it dies in the field, the danger of infection will be removed. Of course, in regard to the cases where animals die in the stables, cremation on the spot may not be possible, but in some of the West Indian stables I have seen the cause of sanitation would be *advanced* by burning down the buildings. I may add that infection may also be carried by flies.

The Hon. B. HOWELL JONES (British Guiana): In 1892 there was an outbreak of anthrax in British Guiana. It attracted attention in consequence of the large number of animals which died; a Commission, on which I sat, was appointed to make inquiry into the matter with the result that the Legislature passed a Contagious Animal Diseases Act. Previous to 1892 I had seen in the colony several cases of what I believe was anthrax, but was unable to verify them by microscopic examination, which is the only means of verifying anthrax. There is a disease, known in England as black-leg, sometimes taken for anthrax, which, until examined under a microscope, is often mistaken for it. That, however, does not exist in our colony. I should like to impress on all members of this Conference the absolute necessity of destroying by fire animals that have died of anthrax. In British Guiana we have recently passed an additional Contagious Diseases Act, by which we make it imperative for the owner, on the death of an animal with anthrax, to inform the police of the district of the outbreak of disease, and, if it is anthrax, that the animal shall be burnt. I am under the impression, as are also others, that the disease has been spread by carrion crows eating the carcasses of animals that have died from anthrax, and as far as I know, all authorities on anthrax insist on the destruction of the animal by fire, which is an extremely easy thing to do. It simply consists of digging a hole near to the carcass of the dead animal, putting wood into the hole, placing two bars across the hole and turning the animal on the cross bars, lighting the fire, and in a short time the animal is consumed; it is, so to speak, burnt up with its own fat.

Dr. MILLAR (Trinidad): The anthrax bacillus is a very vital one; not only does it last for two years, but there are instances in which it has been known to come to the surface of the ground after a lapse of twenty years. Anthrax among Spanish cattle is like the plague with Russian cattle. In this colony, I understand that Dr. Thompson, the Veterinary

Surgeon of San Fernando, several years ago had to deal with anthrax. He used Pasteur's vaccine, but I have not been able to obtain the results of his treatment. I came here in 1902 and did not encounter a case of anthrax until last year, when, in my inspection of animals slaughtered, I came across a Venezuelan ox, which Dr. Dixon and myself verified to have been suffering with anthrax. The chief symptoms which I observed were: the condition of the spleen, the reddish colour of the fat, and the rather blackish colour of the flesh. But the principal lesion which will attract attention on opening the carcass, is the condition of the spleen, which will be four or five times larger than its normal size, and on diagnosing it under a microscope one can at once conclude whether or not the disease is anthrax. On the discovery of this case regulations were made by the Government with the object of controlling the disease. Now, two or three cases occur almost every week among cattle imported from Venezuela. In the colony itself there have been only two cases within my knowledge. On the discovery of these cases we vaccinated the cattle with lympth obtained from the Liverpool School of Tropical Medicine through the Government. In regard to the measures to be taken for controlling an outbreak of anthrax, the first thing to be insisted on is prompt notification. If a sudden death occurs among animals on any estate, and there is no apparent reason for it, the fact should at once be notified to the Government, and inquiry made so that they may be able to ascertain whether or not it is a case of anthrax. If such case is not notified and it should subsequently be discovered to have been anthrax, then the person omitting to give notification should be punished severely. The next thing is disinfection of the premises after notification. That should be carried out under the supervision of a Government official, and unslaked lime and carbolic acid should be used. Again, if anthrax is rife on an estate, compulsory vaccination should be insisted on, and uninfected animals should be isolated for at least three weeks.

The PRESIDENT: Do you have an inspection of imported animals here before they are landed?

Dr. MILLAR: We inspect all animals imported into the colony before they are landed, and as a means of preventing the introduction of anthrax through imported animals, they should be quarantined for a period of three weeks at least; but where large cargoes of animals are imported every week, as in this colony, that might be found to be impracticable. Here we can only enforce a regulation that no animal must be taken out of quarantine station and used until it is examined. If on inspection an animal is condemned, it is taken to the crematorium and burnt. If cattle are imported from an infected place for purposes other than slaughter, it is quite safe to vaccinate them and allow them to enter.

The PRESIDENT: Is vaccination of material value for any length of time?

Dr. MILLAR: Twelve months is the maximum protected period, but it, no doubt, depends upon the condition of health

of the animal. I think the value of the discussion of this subject by this Conference is to point out to the Governments of the several islands that legislation is necessary to deal with this disease. Much practical benefit cannot be derived if one colony imposes regulations while another does not. For instance, there are no regulations in force in Venezuela where anthrax is always, more or less, present. It has been a disease among cattle there for a long time. We in Trinidad depend on Venezuela for our beef, and unless we take precautionary measures we shall always have anthrax with us. If measures, such as I have suggested, were universally adopted and enforced, the West Indian Colonies would never suffer from anthrax.

Mr. WILLIAMS (Jamaica): May I ask Dr. Millar whether I understand him clearly, that vaccination any time before landing would be sufficient protection for a country against infected stock, or would they have to be quarantined for three weeks during which the disease might be in incubation.

Dr. MILLAR: I think if the cattle are vaccinated they could be admitted into the colony.

Mr. WILLIAMS: Suppose you are importing from a suspicious country, would vaccination before admission be necessary?

Dr. MILLAR: It would depend on the voyage. After a voyage of, say, fourteen days, vaccination would not be absolutely necessary. Quarantine might be sufficient.

Mr. WILLIAMS: I should also like to know whether quarantine for three weeks is the practice in Trinidad, or one of the courses which you recommend.

Dr. MILLAR: Quarantine is the present practice.

Mr. WILLIAMS: What steps do you take whether places are infected or not?

Dr. MILLAR: We quarantine all cattle imported here from Venezuela: and if any one wants an animal he gets it out of quarantine.

Mr. WILLIAMS: Is what is known as black-leg a form of anthrax?

Dr. MILLAR: Yes, it is.*

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* This statement is not strictly accurate. While the two diseases are very similar in some of their characteristics, especially in their fatal nature, and the general treatment is much the same in both cases, they are caused by two distinct bacilli, and anthrax vaccine will not bring about immunity from black-leg, nor vice versa. These points are clearly brought out in the following extracts:

'Since quarter ill [or black-leg] and anthrax are both due to specific bacilli, which, although different in form, have equally fatal results, similar steps in the mode of disinfection should be adopted.' (Leaflet No. 102, Board of Agriculture, Great Britain.)

'This disease [black-leg] was formerly regarded as identical with anthrax, but investigations carried out by various scientists in recent times have definitely proved the entire dissimilarity of the two affections, both from a clinical and causal standpoint. The disease is produced by a specific bacillus, readily distinguishable from that causing anthrax.' (*Diseases of Cattle*, Special Report of Bureau of Animal Industry, U.S. Department of Agriculture.) [Ed. *W.I.B.*]

Mr. WILLIAMS: In Jamaica, eight or ten years ago, we had an outbreak of black-leg among young stock from twelve months to two years old; in all cases the animals dying from the disease were burnt. Some attempt was made to protect the stock by inoculation, but the outbreaks were so irregular that the treatment was considered unfavourable. In one year you would lose four or five cattle, a year or two after, three or four; then the disease would disappear for several years. Hence it did not seem worth while to lower the health of your herd for the sake of avoiding the disease.

Dr. MILLAR: The anthrax vaccine must be used pure and fresh: you cannot keep it for a long time.

Mr. WILLIAMS: A friend of mine tells me he has got a good preparation by Parke Davis called Black-leg Cure.

Dr. MILLAR: At home, in treating black-leg, we use the Pasteur vaccine.

RICE CULTIVATION IN BRITISH GUIANA AND TRINIDAD.

The PRESIDENT: In British Guiana rice cultivation has assumed very large proportions. In 1904 the yield of paddy rice was equal to 12,940 tons of clean rice. The industry, however, has fluctuated. The yield in 1897-8 was 15,000 tons; it then fell to 4,700, then to 3,600 tons, then rose to 10,000 tons, then 15,000, and again fell to 12,000. It was a very considerable subsidiary industry which was taken up by people who were for the most part already working on estates; in order to attach the immigrants to the estates, the managers allowed them some land to grow rice, and far from interfering with the estates, it appeared to be a useful means of keeping labour on them.

The Hon. B. HOWELL JONES (British Guiana): The rice industry in British Guiana is slowly and surely growing. A few years ago a comparatively small quantity of rice was grown here and there in small patches, but now the industry has so far extended that hundreds and thousands of acres in rice cultivation may be seen along the district of Essequibo, the west and east coasts of Demerara, east and west coasts of Berbice, and the Corentyne coast. It has, however, in some instances been a boon to the planters, because it has attached certain portions of the coolie immigrants to the estates on which they were formerly indentured; but, I am sorry to say, the general tendency of the coolies at the present moment is to go away from the centre of labour and take up larger areas of land than could possibly be given to them by the sugar estates on which to grow rice. This is partly encouraged by the large coolie settlements established by the Government, by giving the coolies land in lieu of their return passages to India, to which they were entitled under the terms of their original engagement.

That not only relieves the planter of the obligation of giving them return passages, but also relieves the Government of their liability to them. Rice cultivation can never succeed in any country where there is not a regular system of irrigation as well as a proper system of drainage. Complaints have been made that rice is a failure in the district of Corentyne, this being due to want of a regular water supply, lack of drainage, and I am afraid there are more failures than successes owing to no provision being made either for drought or extreme flood. Notwithstanding these failures, rice cultivation has had the effect of scattering a large portion of the coolie population—I suppose in the hope that they will become independent and able to live on their own land. At present this has not been the result, because, during the severe drought through which we passed last year, many of these people have been in extreme want and had to go on the estates to labour. Still, this does not attach them to the estates; they go back again in the rainy season to the outlying districts to cultivate rice. There is a large rice factory in Georgetown which is rented from the Government by Messrs. Wieting and Richter, and from this factory agents are sent out, and paddy is bought at the rate of 1c. per lb. Small rice factories have been erected on the west coast of Berbice, and in one or two other districts, also on a few estates such as Windsor Forest, for the purpose of cleaning rice for the people, and also with the view of obtaining their labour on the estate in the intervals when they are not cultivating their rice fields. As to the yield, in certain places, and in comparatively new land, I have seen 88 bags of paddy, weighing 120 lb. each, produced by a single acre. That, of course, was not an average crop. The average crop on lands properly irrigated and properly drained, would be about 28 bags to the acre; and that would be exceedingly remunerative to the grower. We have found that on certain lands the first crop never comes to ear, or if it does ear, it is of no value: the coolies call it 'wind' rice. It is cut down and fed to the cattle, but in the following year when the rice is again planted a very remunerative crop may be expected. Diseases have appeared in rice fields in certain districts, but at the present moment we know of no absolute cure for them. They are now receiving attention from the Board of Agriculture, with the assistance of the Imperial Department of Agriculture, and I hope we shall find some remedy for them if they get out of hand and impede our operations. With regard to the varieties of rice, experiments have been made by Professor Harrison and Mr. Ward, who is in charge of the experiment fields, and we find that species of 'hill' rice, which are grown in India without water, have grown far better in our swampy land than many other varieties. Samples of these various rices were shown at the Agricultural Society's rooms in British Guiana, and an expert, who did not know the varieties or the names, was asked which were the best samples for our purposes, and curiously enough, the first samples which he pointed out were what is called 'hill-grown' rice. This rice is much heavier than what is known in British Guiana as 'creole' rice. That we should know more about the rice, its

colour, and weight per acre, is shown by what happened when the Carolina rice crop was diseased. There is a variety of rice grown in Carolina and called 'gold' rice, which is used in the New York market; it is a fancy rice, large size, and most beautifully white. I should recommend those who are going in for rice cultivation in this island to try this variety, because it fetches a very high price in the United States market. My time was so limited before I left British Guiana that I have not been able to bring statistics or samples of rice grown at the experiment station; but I am certain Professor Harrison will be exceedingly glad to supply samples to those members of the Conference who desire to have them. We shall not be able to supply large quantities this year, but in another year we shall have various varieties for general distribution to those persons who may desire them.

The Rev. Dr. MORTON (Trinidad): Upland rice was more extensively cultivated, in proportion to the population, thirty-five years ago than it is to-day; indeed it cannot now be regarded as much more than a catch crop. The reasons are simple. It can only be grown on lands on which more profitable crops can be cultivated; it gives a smaller return than swamp rice, and there being usually but one invitation to the birds of the neighbourhood they all accept it, and feast at the expense of the cultivator. The cultivation of swamp rice has grown rapidly in recent years. The first favourite is a long-grained rice called by the East Indians 'Joyiya,' which seems identical with 'Nagra' rice. It is usual to plant all swamp rice in nurseries early in June, and to plant out into the field early in July. But this variety has a tendency in good land to grow very tall and suffer from lodging. To prevent this it is sown more widely in the nursery and kept longer there before replanting. This dwarfs the straw and thus prevents loss of crop by lodging. The next favourite is called 'Mutmuriya' which is short-grained like 'Chitigong.' It is less prolific than 'Nagra.' These two are reaped in October and spoken of as five months' rice. A third variety ('Jarahar') takes six months to mature. This has a longer grain than 'Nagra.' It is very prolific; but the top leaf almost surrounds the heavy ear which it helps to support, and being necessarily cut along with it, gives trouble in cleaning the rice. Other varieties are sweet rice which smells sweet in the field, in the bag, and on the table; black rice, red rice (two varieties), large Upland rice, twelve weeks' rice, and bearded rice. This last has a long awn, somewhat like bearded barley, which is very useful in defending the grain from the attacks of birds. Thirty barrels of 'Nagra' rice in the husk per acre may be taken as a good crop; 24 of 'Chitigong' and 15 of Upland rice, which is equal to about half that number of bags when cleaned. In Trinidad native rice is generally sold in the husk. The price at present is $2·00 per barrel, but it varies with the price of imported rice. Milling has been tried, and in one instance, on the Caroni savanna, with both skill and capital, but the effort is at present in abeyance. The reasons are not far to seek. Rice keeps best in the husk. From October to December bad roads and the moist atmosphere make both transport to the mill and milling difficult. A very large

proportion of the cultivators do not live on their rice fields on the savanna, and cannot store their rice there till the dry season to be milled. The family of the East Indian can clean the rice as it is needed, or others can be hired to do it. All these make the mill a secondary consideration so long as the whole crop is consumed by the native population. Rice is often soaked overnight in cold water and steamed till the husk cracks. It is then dried, after which it is easily husked, and when again thoroughly dried it will keep for a long time. It has then the appearance of 'Ballam' rice. Rice is reaped above the upper joint. In favourable soils and seasons when cut it at once sends out collateral ears and produces a second crop which may be from 40 to 50 per cent. of the first. A small third crop may at times be secured, but this is now generally discarded. After the crop is reaped the cattle are allowed to roam over the savanna, tramping down the straw in grazing upon the herbage which has grown among the rice. When the dry season sets in, the land cracks in all directions and to a considerable depth. This is nature's substitute for man's plough or fork. Low forms of vegetation cover the soil and provide, for half the year, a rotation of crop. With the first showers weeding begins, and the cracks are partially filled with green foliage and vegetable mould. A second weeding completes the process. This is all the manure that is applied. In some of the small swamps, the outlet can be opened or closed to regulate the water supply. These seldom suffer from either flooding or drought. On the Caroni savanna there are places that greatly need large arteries to prevent flooding, and all over the rice lands more attention should be given to *empoldering* the fields and holding in reserve a supply of water. The crop just reaped was reduced by dry weather to less than 50 per cent. of an average crop. The seed used in Trinidad has become greatly mixed, different varieties being very commonly grown together. Something should be done to help this industry by drainage of lands that flood, by improved seed. and by devices for the conservation of the surplus water against a time of drought.

DISCUSSION.

The Hon. B. Howell Jones (British Guiana): In British Guiana no use is made of rice straw beyond feeding it to cattle; the cattle seem to eat it more readily bruised than cut.

The Hon. W. Fawcett (Jamaica): In Jamaica the cultivation of rice is increasing considerably, although not on as large a scale as in British Guiana, because we have not so large a number of coolies there.

The President: Mr. Howell Jones says that the first crop in British Guiana is very often not a success; I believe also that the chief expense falls practically on the first year, so that these two items would be rather detrimental to persons taking up the cultivation of rice unless they have some means. I do not know if this has been the experience in other parts of the West Indies where rice cultivation has been attempted.

The Rev. Dr. MORTON: I have never known the first crop to be a failure in Trinidad. The practice is not to plant a heavy variety the first year.

Mr. C. W. MEADEN (Trinidad): I grew rice once as an experiment, planting it in open drains in a cacao piece, and I got a ton of rice from the first crop.

Dr. FRANCIS WATTS (Leeward Islands): Will rice grow on lands which are slightly brackish or must the water be perfectly sweet? Is it tolerant, in any degree, of salt?

The Hon. B. HOWELL JONES: The experience in British Guiana is that rice will grow on lands slightly brackish. Recently coolies have planted rice in land which has been covered by salt water for many years, and they have been warned that very likely the rice will not grow. I do not think it will grow in salt water.

Mr. G. S. HUDSON (St. Lucia): Rice cultivation has not progressed very much in St. Lucia. Between 50 and 100 acres are under cultivation. We have very few East Indians there, and the creole labourer does not take it up.

Mr. J. E. BECKETT (British Guiana) asked several questions which elicited the following information: that in Trinidad rice was ratooned and two or three crops were obtained from one planting; 'black' rice stained the grain; 'bearded' rice did not affect the milling; 'swamp' rice gave the largest return; 'upland' rice gave about half the yield of the best 'swamp' variety; they were not troubled much with 'wind-blown' rice in Trinidad.

The Hon. B. HOWELL JONES: I should like to mention, for the information of members of the Conference who might not know, that 'white' rice and 'brown' rice are exactly the same. What causes the difference in colour is that rice in the husk is boiled or steamed, and it is this that imparts the colouring matter from the husk to the grain, and rice thus treated is called brown rice. Where we sell one bag of white rice, we sell 50 to 100 bags of brown rice.

The PRESIDENT: Before we close the discussion, I will invite Mr. Ballou to say something about the diseases of rice.

Mr. H. A. BALLOU (Entomologist on the staff of the Imperial Department of Agriculture): Two insects attacking rice have been reported within the past year, but information as to the amount of damage which they do and their life-history is very incomplete. One of these reports came from the British Guiana Board of Agriculture, the other from the medical officer in the island of Leguan where an outbreak occurred. One was to the effect that the insect was likely the cause of damage, and the other that, so far as could be seen, it was not doing any damage; but one thought that the presence of the bug accounted for many empty grains of rice, which were described in the report as 'wind' rice. As far as remedial measures are concerned, it is difficult to say what should be done, without seeing the nature of the damage done by the insects; but I think a careful cleaning up of the fields, either using the straw for some other

purpose or burning it on the spot would be sufficient. We have had sent in from St. Lucia a moth borer in the stem of rice that appears to me to be the same as the rice stalk borer in the Southern United States. The person who sent it in said it was responsible for the abandonment of certain rice cultivations in the interior. This is the only time I have come across the insect. Clean cultivation there, also, is the remedy. In all probability specimens of this borer will be found in the wild grass, and if so, the grass should be cut out and destroyed.

THE SPECIAL QUALITIES OF PLANTS.

BY J. H. HART, F.L.S.,

Superintendent, Royal Botanic Gardens, Trinidad.

1. The influence of the soil on the special qualities of agricultural products.

2. Are the special qualities possessed by plants sufficiently regarded?

It was at first intended that the subjects standing in my name should be taken separately, but they are so nearly connected that it has been deemed preferable to discuss both propositions under the one head.

In dealing with the influence of the soil, I would point out that it is only the *special qualities* that I propose to consider, and that such points as increase in size or quantity of produce are not under discussion.

An idea exists with many untrained tropical planters that certain soils are able to change the character or *special qualities* of plants and their produce. On the other hand, there is no little evidence that such special qualities are inherent to certain individual plants.

In a paper read at the Conference of 1899 (published in the *West Indian Bulletin*, Vol. I, pp. 123-33), I discussed 'Improvement in Agricultural Methods' and pointed out the means by which produce might be improved by the acquirement of varieties of plants by careful selection of the most suitable from the numerous varieties obtained by seminal reproduction.

In not a few instances I have met with positive statements, urging that changes in the special or inherent qualities of plants and produce are, in a large measure, due to the influence of the soil; and the makers of such statements appear to understand that the soil alone is able to induce such changes.

If I may be allowed to change the form of my first proposition and put it in the form of a question, the point may, I think, be made clearer for discussion: Can the characters or special qualities of produce afforded by plants *of one kind* be materially or permanently changed or altered, by the influence of the soil?

In using the words 'one kind' I do not intend them to cover the numberless varieties produced from seed, as these are well known to be subject to wide variation, but only those plants which are propagated in pure strains, by budding and grafting, or, as it is sometimes termed, 'vegetative reproduction.'

It will, I think, be obvious to most of us that the two conditions are essentially different, as it is fairly clear that either degradation or improvement may follow when plants are raised from seed, while, on the other hand, special qualities or characters can be indefinitely secured, by means of vegetative reproduction.

It may, however, be truly asserted, that produce can, and often is, improved by cultivation on a good soil, and that the measure of improvement mainly depends upon the amount of plant food present, and the methods of cultivation used to render it available.

It can also be shown that quality may be improved by manipulation in preparation of produce; as in the fermentation and drying of cacao, etc. Changes effected by manipulation are, however, somewhat limited, and it would be next to impossible to make inferior material into first-class produce by such means, although it certainly may be considerably improved. As an illustration, I would point out that Calabacillo cacao, prepared by the very best method, can never be compared with the finest strains of Criollo or Forastero, similarly prepared. It is evident that Calabacillo must always remain inferior, because, in special qualities, it is originally inferior. We cannot in fact, to use a common expression, 'make a silk purse out of a sow's ear.'

Changes of this class are, I consider, minor improvements, but cannot be regarded as referring to special qualities. The latter may be defined as the factors which separate inferior from first-class produce.

It becomes evident, therefore, that, where first-class kinds are planted, the produce can be confidently relied upon, provided, of course, that it is properly grown and handled. Even if handled without care, such produce is often far superior to that which belongs to an inferior class.

On further study of the matter, we find very strong evidence that plants showing special qualities, if reproduced by budding and grafting, will maintain their qualities under varying conditions of soil, i.e., they will not materially change.

Who, for instance, could change a white into a black grape, or a Julie into a Gordon mango, by the influence of the soil? A special quality is essentially an individual characteristic possessed by a certain plant not subject to serious change from the influence of the soil. That changes of a kind can and do take place is easy to discover; but they are merely such as would leave a white grape still a white grape, and the Julie mango still a Julie, and nothing else, wherever planted.

Plants are known to have retained, or to have maintained their individual qualities and special characters for centuries

no matter where, how, or in what kind of soil they have been planted.

The effect known to be produced upon plants by a new environment may effect them to a certain degree, but it is probable that the influence of the soil is a minor factor even in this case, and can, from a cultivator's point of view, be practically disregarded when dealing with plants indigenous to, or imported from, a similar climate to that in which they originated.

Professor d'Albuquerque, in discussing chemical selection of sugar-cane at this Conference, gave strong evidence in favour of the permanence of individual special qualities in plants. He showed variation and improvement, but in the end all came out alike—that is, the special qualities were unaffected.

In support of the statement that no material change occurs, I would mention the continuance of the special qualities in the varieties of European grapes, apples, pears, plums, etc., under cultivation. The Ribston Pippin apple, first recorded some three hundred years ago, has continued to maintain its special qualities, although cultivated on all classes of soil and in all climates in the temperate zone. It is still the Ribston Pippin: and by a late census, taken during 1904, it is placed about fourth in the list of dessert apples, in English collections. Had its propagation been left to reproduction from seed, in the manner cacao has been for so many years, it certainly would have long since disappeared as a variety possessing special qualities; but by the aid of continuous vegetative reproduction, this apple has been handed down from father to son for many generations, and still stands among the first of its class.

In Europe and America similar illustrations are abundant; but they have been extremely rare in the West Indies until in very recent years, when a commencement was made in perpetuating special, selected varieties of the mango, orange, and other fruits, by budding and grafting.

The sugar-cane and the pine-apple afford two instances in which special characters have been maintained, and we find in these two instances, that the plants have been propagated by cuttings and suckers, which are processes of 'vegetative reproduction.' Both are now being propagated from seed, with the result that many new varieties have been secured by selection from thousands of seedling kinds, each of which may, by the means mentioned, be perpetuated at will.

The supposition that the soil changes plants may possibly have arisen from the natural variation which occurs among plants raised from seed, a fact which has been insufficiently noticed, or regarded, by the general cultivator, and even if noticed, has been wrongly attributed to the influence of the soil. Reproduction from seed is clearly the best method of securing new varieties, but unless combined with careful selection, it gives rise to sets of plants showing a mixture of both good and bad qualities, the latter being generally the more numerous. It is therefore evident that a process of raising

seedling plants without selection must inevitably tend to the deterioration of any class of plant so raised.

Once found, however, a special quality can certainly be perpetuated. This brings up our second proposition, namely: Are the special qualities of plants sufficiently regarded?

It is a well-known fact that among progressive agriculturists these qualities are considered of the highest importance, and as such, are being earnestly sought. So much is this the case, that it has formed a fully sufficient *raison d'être* for the establishment of modern experiment stations in most countries where agricultural work gives employment to a large proportion of the population. The duty of such stations is to search out and perpetuate the newest and best varieties, to test such, and to bring them into cultivation.

Hitherto such work has not been sufficiently regarded, but I am glad to be able to say that, among the planters of Trinidad, there are those who now take the greatest interest in it; but still there is a large number of planters who do not as yet realize the vast importance of having under cultivation the highest class of plant which it is possible to secure.

I have but briefly opened the two propositions submitted for the consideration of the Conference, and it will be noticed that I have not said as much for the influence of the soil as I have for other influences. It must be remembered, however, that I have merely touched upon the subject, and have not attempted to exhaust it, for or against, either proposition. Personally, I believe the subject to be of the very highest importance, and that the special qualities of plants should be much more widely considered than they are to-day, especially among cultivators who have had no opportunity for practical training or careful study in the theory and practice of agriculture.

I now offer the subject for discussion, pointing out that the main object of the paper is to bring prominently to view the immense importance of selecting and growing pure strains of high-class plants, and of propagating these by vegetative reproduction. The common and untrustworthy method of using unselected seedlings is a practice which is fraught with danger to the prosperity of the country in which it is pursued, while, if the qualities of individual plants are sufficiently regarded, and the methods I have suggested adopted, I believe it will result in raising the value of the produce grown, to the benefit of the cultivator, and of the country in which he lives.

THE IMPORTANCE OF SELECTION IN VEGETATIVE PROPAGATION.

BY W. R. BUTTENSHAW, M.A., B.Sc.,

Scientific Assistant on the staff of the Imperial Department of Agriculture.

The question whether plants propagated by vegetative processes could be improved or permanently modified by selection has often been debated. In most of the processes of vegetative propagation the new growth is merely an extension of the growth of the parent, and, consequently, the new plant produced in this way is much like its parent. But since even among the different branches of one tree there can be variation —sometimes sufficiently obvious to become a 'bud sport'—it is easy to imagine that cuttings produced from the same parent may develop considerable variation.

It is well recognized by gardeners that a new individual produced from a cutting possesses certain characters which may or may not differ from all other similar parts of the parent plant; in other words, hardly any two cuttings possess exactly the same characters; that it is also necessary to make use of careful selection when propagating plants by a vegetative process is therefore apparent.

A very complete series of experiments has been carried out by Messrs. B. T. Galloway and P. H. Dorset, of the Division of Vegetable Pathology of the U. S. Department of Agriculture, to determine to what extent violet plants could be improved in productiveness, vigour, and ability to resist disease by a careful selection of cuttings. A detailed account of these experiments is given by Mr. Herbert J. Webber in the *Yearbook of the U.S. Department of Agriculture* for 1898 (pp. 373-5). He says: 'The results already show that productiveness is remarkably increased, and they also clearly demonstrate that violet cuttings can gradually be improved by a continuous selection of the cuttings used in propagation and of the plants from which these are obtained. The method consists in selecting a number of the finest-looking plants before they begin to bloom, placing beside each a stake to which a blank tag is attached, and carefully recording on each tag the daily pick of saleable flowers from the plant, so that at the end of the season the number of flowers produced by each plant is known. The cuttings for the ensuing year are taken only from the plants producing the greatest yields, and which are known from continual observation through the season to be desirable in other ways. The pedigree cuttings thus obtained are again subjected to selection, and only those which root well and form good, vigorous, young plants are finally used.'

The following is an interesting example of the nature of the results obtained: Five plants were selected from a plant which, in the previous season, had yielded eighty-five flowers. Three out of these five gave a much greater yield than the parent (127, 109, and 108,) the remaining two gave eighty-two and

eighty-four, respectively. The average yield of the five plants is thus 101, or sixteen flowers more than that of the parent.

Selection in vegetative propagation is also of assistance in producing a healthy strain of plants. Webber gives an account of experiments with the Ripley Queen pine-apple, which is liable to a disease which causes it to 'go blind,' that is, advance to the end of its growing period and sucker from below without fruiting. The experiment consisted in planting in one bed suckers from diseased plants and in an adjoining bed suckers from apparently healthy plants. In the former bed, eighteen months later, he found that 63 per cent. had contracted the disease, while in the other bed slightly less than 4 per cent. showed the disease. This being the result of but one selection, it would seem probable that the disease might be completely controlled by a continuous selection of suckers from healthy plants.

Another interesting illustration of the modifications obtained by the careful and continued selection of vegetative parts—one of particular interest in West Indian agriculture—is the breeding out of thorns from citrus trees by bud selection. To quote again from Mr. Webber's article: 'Seedling oranges and lemons are almost invariably very thorny, but nevertheless the majority of the standard varieties cultivated are now largely thornless, owing, it is said, to the continuous selection of buds from thornless branches. According to the testimony of orange nursery-men, it is quite certain that thorns can be bred out in this way in every case, and usually to do so requires but three or four bud generations. It is probable, in the case of other fruit trees, that by selecting buds or cuttings from branches that are thornless, or which have fewer thorns than usual, the thorns could be entirely bred out, or at least the greater number reduced.'

Writing in the *Bulletin of the Botanical Department of Jamaica* for November 1900 on the subject of budding orange trees, Mr. W. Cradwick says: 'Buds with thorns attached should not be used; they do not grow so readily, and, if they grow, result in a tree on which long thorns will be one of the chief features. A tree grown at Hope from a bud with thorns 1¼ inches in length attached to it produced thorns over 8 inches in length.'

In this connexion it may be useful to review briefly the interesting series of experiments in the chemical selection of sugar-cane conducted by Dr. Watts at Antigua:—

'The object of the experiment is to ascertain whether the saccharine content of the sugar-cane can be effected by selection of cuttings.' These experiments consist in selecting two series of canes—(1) canes rich in sucrose, called 'High' canes, and (2) canes poor in sucrose, called 'Low' canes. The experiments have now been in progress for four years. Each year the ten richest canes have been selected from the 'high' plot and the ten poorest from the 'low' plot. This represents an attempt to obtain two divergent series—'one tending to increased richness, and the other to decreased richness.' In making the selection, the canes are examined by cutting off

the basal portion in the middle of the fifth internode from the base, crushing this basal portion in the Chatanooga mill, and determining the amount of sugar by means of the polariscope in the sample of juice so obtained.

The results so far attained are as follows:—

	Pounds of sucrose per gallon.				
	1900.	1901.	1902.	1903.	1904.
Difference on canes planted,	·597	·526	·985	·463	·876
	1901.	1902.	1903.	1904.	
„ „ „ reaped,	·020	·218	·093	·199	

The difference on canes planted in 1900 and 1904, in pounds of sucrose per gallon, has increased from ·597 to ·876, an increase of 46 per cent. Similarly, the difference on canes reaped in 1901 and 1904 has increased from ·020 to ·199.

In considering this question it is essential that two points should be clearly distinguished. Briefly put, it is the difference between the maintenance of a 'sport' and the gradual improvement by selection. My meaning will be made clear by another reference to the case of budding out thorns from citrus plants. If a bud is taken from a spineless branch and the resulting tree comes spineless, then we may have simply perpetuated a sport. But can we rely upon all such buds being spineless? This would appear not to be the case, for Mr. Webber says: 'Standard varieties are now *largely* thornless;' and again, 'it is quite certain that thorns can be bred out in this way in every case, and usually to do so requires but three or four generations.' It is evident that we have here a *gradual* process, that the variations between spineless and spiny buds are not uniform but differ in degree, and, lastly, that *continued* selection is necessary before the spine can be eliminated. The same fact is brought out—but in the contrary direction—in the instance cited by Mr. Cradwick, where a tree grown from a bud 1¼ inches long attached to it produced thorns over 8 inches long; it is obvious that it would be possible here also to produce two divergent series of oranges—one becoming less and less spiny and the other tending to produce longer and longer thorns.

BUTTER MAKING IN TRINIDAD.

BY C. W. MEADEN,

Manager, Trinidad Government Farm.

Very little information is available for guidance in the process of butter production in a climate similar to that of Trinidad. To follow the rules laid down for manufacture in a temperate climate does not result in success, and a method has to be found to suit our particular conditions.

The following information is given as the result of an experiment here which, it is claimed, has been the means of turning out a good, marketable article, sufficiently so to compete with any butter imported on the points of quality, purity, and flavour. As much as 1 ton of this butter was made and sold in 1902 and realized £292.

The description herein related applies entirely to the Government Farm, and the same treatment may not be applicable elsewhere. But the object is to state it in the simplest manner, so that what has been done may readily be understood.

Various analyses are included to show the quality of the milk and cream handled, and the other products resulting from the manufacture of the butter.

The experiment was continued throughout one month; the quantity of milk daily passed through the separator was limited to 40 imperial quarts, which gave 4·47 quarts of cream per diem; this quantity gave 4·33 lb. of butter, or about 1 lb. to the quart of cream. The separated milk returned was 910 quarts, thus showing that it took 217 quarts of cream to make 129·9 lb. of butter, or about 9¼ quarts of milk to 1 lb. of butter; the butter milk remaining amounted to 73 quarts.

Cream churns most perfectly when its thickness is such that a gallon will yield 3 lb. of butter. This has been slightly exceeded, but the foregoing may be considered equivalent to the basis laid down from experiments in temperate climates.

SERIES OF ANALYSES.

	Percentage.			
	Fat.	Solids not fat.	Cream.	Specific gravity.
Milk—average quality	5·00	9·15	9·00	1,026·5
Cream separated from same ...	49·06	6·66	...	964·14
Separated milk	0·18	9·33	0·50	1,033·5
Butter milk	7·05	7·77	...	..

The resulting butter had the following composition:—

Fat, 84·40; curd, 0·67; salt, 0·97; water, 13·96. It will be observed that the separation is very complete, only 18 per cent. of fat remaining in the milk treated.

SEPARATING.

The first essential for successful butter making in the tropics is the mechanical separation of the milk. The long delay

in setting milk in pans for creaming is fatal to its flavour; by separating the action of the temperature on the ripening of the cream can be controlled and an evenness of flavour in the butter can be produced.

The separator used is an Alpha-Laval with a capacity for separating 55 gallons of milk per hour. The speed ranges from 3,000 to 4,000 revolutions per minute. This seems to be a safe speed, much depending upon this for complete separation, and the drum of the machine should be at full speed before the milk enters. The action of the machine is simple. By rapid revolutions the lightest portion of the milk, i.e., the cream, is thrown up to the surface and skimmed off by tubes or forced out of the machine by the pressure of the inflow of new milk. A most important consideration in the separation is that the whole of the dirt is removed from the milk and thrown out to the farthest point of the drum; then the skimmed milk is left in a form which is immensely superior to that of skimmed milk obtained in any other way.

The rate at which the milk is supplied to the drum controls the rate at which it must leave it and also regulates the thickness of the cream. If the milk is allowed full flow, the cream is then thin and the separation is not so perfect: the slower the milk enters the thicker will be the cream. The temperature here seems to be exactly right for complete separation, viz., 85° F., from 3 to 4 p.m. A strong boy can work such a machine as here described.

CHURNING.

After separation the cream is placed in the churn, which is a 'Champion,' having a capacity of 3 gallons with an end-over-end movement. Churning takes place from 6 to 7 a.m., the temperature then being about 75 F.; should it be higher no attempt is made to reduce by cooling, as there is no advantage to be gained in doing so. It has been found that by reducing the temperature to harden the butter for working, when it regains the normal point, it melts and remains in a semi-solid condition.

Without the aid of ice the butter remains firm and can be cut out and spread at any hour of the day. Kept in a cool current of air the butter will remain sweet and palatable for days. The change from adding ice when on the table to the usual heat quickly destroys the flavour. The length of time in churning to obtain the butter is generally about twenty minutes, but the period seems to be greatly regulated by the condition of the weather. When the butter is delayed in coming, it can be aided by adding a quart or so of water to the cream. The addition of water hardens the granules, gives a thinner body of liquid on which they can float apart, and prevents their gathering too rapidly and enables the butter to be taken from the churn without waste.

Afterwards the butter milk is drawn off through a fine hair sieve into a pail. Fresh water is then poured into the churn (about 1 gallon to each pound of butter); this is rocked sharply for a few turns and then drawn off, the washing is continued until the water leaves the churn clear and free from milk.

Brine can then be used for salting. This is a good plan in the tropics, as there is an even distribution of the salt, brine can be made by dissolving 2 to 3 lb. of pure salt to the gallon of water. This is added to the butter in the churn, a few sharp turns being given and then left for half an hour. The butter can then be removed and worked to remove the water; salting is a matter of taste, i.e., whether it should be mild or strong. Of the two methods I prefer dry salting, but this necessitates a little more work and care to see that the salt is evenly distributed.

WORKING.

The most difficult part of the manufacture of butter in this climate is the effectual extraction of the water. The analysis shows nearly 14 per cent. remaining in the sample analysed. This is probably as low an extraction as possible and shows good working. The percentage falls below the limit recently permitted by the Board of Agriculture of Great Britain, 16 per cent., so that there is a satisfactory margin.

Particulars as to the amount of water retained in the butter where the manufacture forms a leading industry show that in

Danish,	13,533	samples	analysed	averaged	14·25	per cent.
Sweedish,	8,340	„	„	„	13·57	„ „
Irish,	2,126	„	„	„	14·08	„ „

A 'Delaiteuse' was used at first for mechanical extraction but failed, as in its action the butter oil was thrown off with the water, and this spoilt the butter.

An ordinary butter worker is best, or working with Scotch hands for small quantities. It should be twice worked, first as much as possible and then add the salt, let it remain for a time and then work again before packing. This has given the best results. In twenty hours the article is ready for market. Packed first in butter paper and then in card-board boxes, it is practically air-tight and will harden and keep sweet without the aid of ice. At no time during butter making should the workers' hands touch it.

The general colour is good, and no colouring agent is added. The colour is due to a principle called 'Lacto-chrome.' This is a delicate constituent and can easily be injured, especially in the process of washing, brining, or by over salting; if the butter is over salted, and it is desired to reduce this, the colour will be removed to a great extent in extracting the salt.

Feeding cotton seed meal to cows is said to improve the natural colour of the butter and further to enable the cream to be churned at a higher temperature; but from experiment I am not prepared to concede this, as 4 lb., fed daily to cows (a limit that cannot be exceeded with safety) produced no perceptibly stronger colour above ordinary feeding, or grass only, and no value was received for the additional cost incurred.

FLAVOURING.

Cream is ripened to improve the yield, flavour, and keeping quality of butter. On the separation system a good starter is

absolutely essential in the process. It hastens the development of lactic acid and controls, to a great extent, the flavour of the butter. It is of the first importance that this starter should be of the right degree of acidity so as to communicate its action to the new cream. This action is set up by bacteria, but on this point, in a simple paper like this, the scientific aspect is not dwelt upon.

The flavouring agent should be ready for adding to the cream as soon as separation is finished; the temperature of the agent to be about 100° to 102° F., that of the cream generally 82° F. These temperatures seem to give favourable results in improving the flavour of butter.

A starter is prepared by setting a sufficient quantity of the separated milk in a special vessel covered with muslin. This is set at about 4 p.m., and in the morning the vessel is placed in the sun to make the fermentation more rapid. After remaining in this position for from ten to twelve hours the curd is removed and the resulting whey is in right condition for adding to the cream. It is then filtered into the churn and well stirred into the cream. The whole is then left until the morning for churning.

In this operation no expensive or intricate apparatus is involved. It proceeds only on the simplest lines; so that any one without special training could follow the procedure. In this way the object sought was to encourage the manufacture of butter, for which there is a ready and remunerative demand, provided, of course, it is conducted on business principles and there is no sale for the milk.

A chemical basis of acidity should first be ascertained, afterwards litmus paper will indicate sufficiently near the right point, but practice, taste, and smell are fairly reliable.

In this new and interesting work Professor Carmody kindly gave me his scientific assistance, and to this whatever success there may be in butter making in Trinidad is certainly due.

FINANCIAL RESULTS.

In these experiments the object has been to produce a clean, pure, wholesome article that would meet public approval and compete successfully with the best quality of the imported product. That this prime fact has been achieved is proved by the keen demand for the local article and kind expressions of approval.

Financial results form the most interesting and conclusive test as to the value of the business, and the practical results of the experiments and its money value are related herein. I may add that the butter making at the Farm has gone far beyond the experimental stage, and as much as 2½ cwt. have been made and sold in one month; the output depends entirely upon the demands for milk from the hospitals.

The details of the experiment are as follows:—

		$ c.
Made 130 lb. butter, sold at 48 c. per lb. ...		62 40
5 cows milked, 1,200 quarts ...		
Milker	$7·00	
Feed	7·50	
Woman and boy	6·00	
Packing and delivery	1·60	
		22 10
		40 30
Less 20 per cent. supervision, taxes		8 00
Return, say,		$32 30

Each cow gave 2 imperial gallons of milk daily, and the profit shown works out at $6·40 per month for each animal. On a sufficiently large scale there is apparently money in butter making, where there is no possibility of retailing the milk. Of course, if the milk had been sold, the return would have been practically double. In butter making there is always the value of separated and butter milk and calves to be included in the returns.

In conclusion, I have tried to show, as far as my knowledge goes, within the limits of this short paper, the possibilities of butter making in the tropics. As stated, there is not much information for guidance, and if anything herein can contribute towards success, the writer will be repaid.

DISCUSSION.

Professor P. CARMODY (Trinidad) presented samples of the ordinary butter imported into the West Indies, which he said were of French manufacture and by no means as good as the butter made at the Government Stock Farm, as analyses had proved, the latter being worth 2*d.* to 3*d* per lb. more than any imported butter.

The PRESIDENT: What is the value of milk in Trinidad?

Mr. MEADEN: Four pence per bottle containing about 1½ pints.

Dr. FRANCIS WATTS (Leeward Islands): It seems to me that it would be better to sell the milk than to buy it at 8c. per pint to make butter.

Professor J. P. D'ALBUQUERQUE (Barbados): It is due to Mr. Meaden to state that some of us have eaten butter made by him, and it is an absolutely different article to anything you can possibly import here. It is an article of luxury, and as such I think it should command a much higher price here. The quality of the article is certainly a triumph for Mr. Meaden and those associated with him.

Mr. MEADEN: The reason why butter making was started was that we had more milk than the hospitals required, and instead of feeding it to the stock I started butter making and, so far, it has been a success. I am quite satisfied that, where there is no sale for the milk, butter making is profitable.

Mr. W. N. SANDS (St. Vincent): I have been connected with butter making in Antigua, and I was very much struck, on visiting the dairy at the Trinidad Government Farm, to find that such excellent butter is made without the use of ice. We found great difficulty in Antigua in keeping down the temperature and had to resort to the use of ice; and I think the great point in Mr. Meaden's process is that he has shown us that it is possible to make such firm butter without using ice.

In reply to the PRESIDENT, the price of milk in the different islands was stated by the various representatives to be as follows:—

Antigua,	2*d.* to 2½*d.* per bottle, equal to 1*s.* to 1*s.* 3*d.* per imperial gallon.
Barbados,	1½*d.* to 2*d.* per pint.
British Guiana,	2*d.* to 3*d.* per pint.
Dominica,	2*d.* per bottle (whisky).
Grenada,	3*d.* per pint.
Jamaica,	2¼*d.* to 3*d.* per pint.
Montserrat	½*d.* per bottle.
St. Kitt's,	2*d.* per bottle (whisky).
St. Lucia,	2*d.* to 2½*d.*
St. Vincent,	1*d.* per pint.
Tobago,	1*d.* per pint.
Trinidad,	4*d.* per bottle of 25 oz., equal to 2*s.* per gallon.
Surinam,	5*d.* per bottle, equal to 3½*d.* per pint.

BARBADOS WOOLLESS SHEEP.

BY W. R. BUTTENSHAW, M.A., B.Sc.,

Scientific Assistant on the staff of the Imperial Department of Agriculture.

It is evident that woolless sheep have been in Barbados for a very long time, for Ligon, describing the local fauna in his *History of Barbados*, 1657, says: 'Other sheep we have there, which are brought from *Guinny* and *Binny*, and those have haire growing on them, instead of wool; and liker goats than sheep, yet their flesh is tasted more like mutton than the other.'

This breed of sheep is almost entirely raised in Barbados and some other parts of the West Indies. It is believed to be of African origin. The sheep are very hardy, and in dry districts, especially near the coast in the parish of St. Philip, where sufficient food is available, they are regarded as the most profitable of any of the mutton breeds. The flesh is of excellent quality and much appreciated in the West Indies.

The best sorts are covered with brown hair above with black bellies and legs. The face is also usually black, but it sometimes has two whitish lines running down from the forehead to the nose.

The animals are not, as a rule, kept in large flocks in Barbados; but nearly every peasant proprietor in the drier districts round the coast has a few of these sheep, which are usually tethered to a peg while pasturing in the day time and placed under cover at night.

SIZE OF SHEEP.

I found that a nicely shaped young ram, about twelve months old, measured 28 inches at the shoulder. A ewe aged three years measured 25 inches. As showing what care and attention can do in improving these sheep, it may be mentioned that a daughter of this ewe was only 1 inch shorter, although no older than five months. The mother had been purchased, not bred, by the owner.

LIVE WEIGHT.

I have obtained particulars of the weights of a large number of what might be called 'show' stock. Some of these are as follows:—

No. 1.—Weighed 152 ℔. at the early age of between ten and eleven months. This sheep was raised by a small shopkeeper in Bridgetown and for food obtained pickings from around the shop. But as these scraps of food consisted largely of such refuse as pigeon pea shells, it is possible that this sheep was more highly fed than is often the case. It was a prizewinner at the 1902 Exhibition; and afterwards was sold to the butcher for $14—or at a little over 9c. per ℔.

No. 2.—Weighed 130 ℔. at sixteen months; entirely grass-fed. The same man raised:—

No. 3.—Which weighed 70 ℔. at the early age of six months.

No. 4.—This animal was shown at the Exhibition of 1897 when just cutting his first two broad teeth. Its age may be taken, therefore, as about eleven months. Its live weight was 125 ℔. It might also be mentioned that this sheep was one of four at a birth. In this case grass feeding was supplemented by a little grain and mash.

It will thus be seen that it is not uncommon for well-fed wethers to reach 120 ℔. to 130 ℔. (live weight), when about fifteen months old.

PRICES FETCHED BY SHEEP IN BARBADOS.

Sheep are usually bought by butchers in Barbados at a regular price per ℔. of live weight. At the present time this is 7c. per ℔. for fairly fat sheep. An animal weighing over 110 ℔. would sell at the rate of 8c. per ℔. Prices have declined somewhat during recent years. Some six or seven years ago the prices ran thus:—

6c. per lb.	for animals	weighing			60 lb. (live weight)	
7c.	,,	,,	,,	,,	70 lb.	,,
8c.	,,	,,	,,	,,	80 lb.	,,
9c.	,,	,,	,,	,,	90 lb.	,,
10c.	,,	,,	,,	,,	100 lb. and over (live weight).	

For the information of stock owners who might desire to obtain these sheep from Barbados, it might be stated that their cost, f.o.b. at Barbados, would probably be about $10 to $12 per head. Mr. Farmer at 'Halton' had some nice young rams, from twelve to fourteen months old, which he was willing to sell at $10 ; also full-grown ewes, in kid, at the same price. There was formerly a uniform price of 10*s*. for weanable lambs ; these can, however, now be obtained for about half that sum. An unbred ewe sent to the butcher would not fetch more than at the rate of 5c. per lb. (live weight).

Sheep owners in Barbados usually try to get their animals to the butcher at twelve months. It is not considered that the increase made in weight after this age is sufficient to pay for extra trouble and expense. Probably the average weight of grass-fed sheep at this age is about 90 lb. With a little extra feeding, however, this can easily be raised to 100 lb.

PROPORTION OF MUTTON TO LIVE WEIGHT.

My inquiries in this connexion lead me to place the weight of mutton at about one half the live weight in the case of sheep of average weight, say, 80 lb. to 90 lb. ; for heavier sheep the proportion is slightly higher. In other words, Barbados woolless sheep weighing less than 100 lb. 'dress' about 50 per cent. of their live weight, heavier animals 'dressing' from 54 to 55 per cent. An animal weighing 80 lb. would give 40 lb. of mutton, one weighing 100 lb. from 54 lb. to 55 lb. The fact that these woolless sheep 'dress' better than the local woolly sheep is, of course, the chief reason for the preference entertained by butchers for them. While a woolless sheep weighing 100 lb. would give from 54 lb. to 55 lb. of mutton, a Barbados woolly sheep of the same weight would give less than 50 lb.

REARING AND MANAGEMENT.

Male lambs are castrated at two or three weeks. All lambs usually run with their dams until about seven or eight weeks old. It is not found advisable to wean lambs that are to be shipped before they are twelve weeks old. Rams are ready to serve at six or seven months ; and ewes can be put to the ram at about twelve months.

Next, with regard to feeding ; this is usually a very simple matter, most of the sheep in Barbados being entirely grass-fed or, at any rate, getting nothing else than sweet potatos when these are plentiful. Sweet potatos should be sliced and sun-dried.

There can be no doubt that these sheep can be got ready for the butcher much earlier and with better results if some supplementary food in the form of grain is given. One very

successful raiser worked out the feeding question very carefully, and was fully convinced of the advantage of feeding grain. His lambs, as soon as they were weaned, received a daily allowance of a watery mash of corn meal, pollard, and a very little oil meal every morning. He commenced to prepare his wethers for the butcher at three months; these received crushed corn or oats up to 2 pints a day and dried sweet potatos.

It would appear that Barbados woolless sheep are particularly profitable to keep on account of their prolificness. A ewe generally has two or three lambs at a birth, four, and even five, being not uncommon occurrences. The ewes usually have no difficulty in rearing their young, though naturally some assistance in the form of nutritious food, such as bran or corn meal, is necessary when a ewe has more than a couple of lambs.

By many breeders, too, they are considered more suitable to local conditions by reason of their woolless coats being untroubled by 'burrs' which are so common in most pastures.

It should be clearly understood that the present representatives of this breed are far from being pure bred. The effect of crossing at some time with imported woolly sheep is constantly to be seen. The offspring of fairly typical woolless sheep are quite likely to develop wool. In fact, it is estimated by an experienced sheep raiser in Barbados, who made a specialty of the woolless sheep, that probably 10 per cent. of the progeny of woolless sheep are more or less woolly, it being quite a common occurrence for one lamb, of two born at a birth, to be quite woolless and the other woolly. From inquiries made into the origin of the wool, it appeared that, though no woolly sheep have been imported in recent years into Barbados for breeding purposes, fifty or sixty years ago American sheep were imported and these no doubt were crossed with the hairy sheep already in the island.

Seeing that these hairy sheep are preferred to the woolly kinds by the local butchers, it would seem to be worth while for any one who raises them on at all an extensive scale to attempt to breed out the woolliness by careful selection of the best woolless types. This is being done now to a small extent by Mr. J. A. Farmer, of Halton, St. Philip, who has quite a nice little herd of woolless sheep. If this were seriously attempted, however, there would be a distinct danger of in-breeding, since all these animals must be fairly closely related. This could, no doubt, be avoided, and possibly an improvement brought about, by fresh importations from West Africa. I understand that in the Lagos Colony sheep of this kind—that might also be described as 'liker goats than sheep'—are very common.

Woolless sheep have been distributed by the Imperial Commissioner of Agriculture to most of the other West India Islands, where they are reported to be doing well and proving useful. Thus, in St. Lucia, the small flock, started at the Agricultural School in August 1902 with a trio, increased in nineteen months to ten. Of these one young ram, which at eight months old weighed 82½ lb., was sold to the Stock Farm at Antigua. Again, the Agricultural Instructor at Tortola

reports: 'The woolless sheep kept at the station continue to thrive. Nine lambs were reared from three ewes during the year. One ewe gave birth to five lambs in October 1903, but two died, three being reared. This breed is certainly well suited to Tortola. There is a large demand for the young sheep.'

BARBADOS SHEEP FOR THE UNITED STATES.

In July 1904, five of these sheep—four ewes and one ram, all yearlings—were, at the request of Dr. D. E. Salmon, Chief of the Bureau of Animal Industry, U.S. Department of Agriculture, procured by the Imperial Department of Agriculture and shipped to New York. Dr. Salmon reported on July 13, 1904, that the animals, which were then at the Quarantine Station, were in 'excellent condition and doing nicely. They were eating well and apparently had suffered no ill effects from the voyage.'

The following note on this experiment appeared in the Barbados *Advocate* of December 9, 1904:—

An interesting experiment is being made by the U. S. Department of Agriculture in the importation of woolless sheep. They are brought from Barbados.

It is believed that woolless sheep will thrive in the extreme Southern States, and provide a profitable industry in the climate where the ordinary sheep would suffer on account of its covering.

Sir Daniel Morris, Imperial Commissioner of Agriculture for the West Indies, called the attention of the U. S. Agricultural Department to these woolless sheep and recommended that they be introduced into the United States. Accordingly, five were imported, and are now quartered at Bethesda, Md., a short distance outside the district of Columbia.

Since arriving there it is stated that one has grown a considerable amount of wool on its shoulders. This is accounted for by the fact that the climate of Maryland is considerably colder than that of the West Indies.

It is thought that when the flock is sent south this growth of wool will disappear.

The woolless sheep of Barbados are thought to be of African origin, although but little definite information is available on this point. They are hardy, and in dry districts are profitable.

It remains to be seen whether the characteristics of the mutton from these sheep will be changed by rearing in the Southern States, but no fear of deterioration in quality is felt. Indeed, it is thought not unlikely that the quality may be improved by more careful feeding and methods of raising.

The sheep imported by the U. S. Department of Agriculture are yearlings and weigh about 80 lb. If they thrive in the southern section, to which they will be sent, additional importations will be made and the new breed distributed among farmers who will undertake to give the experiment careful test.

It is expected that the new industry will prove a source of considerable profit in a climate where sheep raising is not now an important branch of agriculture.*

AFRICAN HAIRY SHEEP.

At the request of Mr. R. Lydekker, F.R.S., a skull and a skin of one of these sheep were obtained in Barbados by the Imperial Commissioner of Agriculture and presented to the British Museum (Natural History), where they have been mounted and are now on exhibition. Mr. Lydekker wrote to the *Field* as follows on this specimen:—

Those interested in the origin of our domesticated breeds of sheep should pay a visit to the Natural History Museum to inspect a very remarkable type which has just been added to the collection in the North Hall. The specimen in question is a ram of the red, hairy breed of sheep native to the West Coast of Africa, whence it has been exported to Barbados, the birthplace of the present example. Although an adult ram, the museum specimen has no signs of horns, but I believe these appendages are developed, in some instances at any rate, in the original African breed. The most striking features of the Barbados ram (which, by the way, was presented to the museum by the Commissioner of Agriculture for the West Indies) are, firstly, the uniformly foxy-red colour of the coat, and, secondly, the short and hairy nature of the latter, which displays no tendency to woolliness, and is almost exactly similar to the summer coat of the wild mufflon or oorial. The head is, in fact, almost identical in form and general appearance with that of a female of one of those two species, and thus quite different from the long and slender head of the African wild sheep or oodad, which has been regarded by some as the ancestral stock of the domesticated breeds. The tail, too, is much shorter than in European domesticated sheep, not reaching to within a considerable distance of the hocks. From the uniform colour of the coat it would seem probable that the breed is more nearly related to the oorial than to the mufflon, and if the former were originally domesticated in Persia, it might well have been introduced into Africa by way of Syria. Be that as it may, it seems most likely that in the West African breed we have the earlier stock of the more specialized woolly breeds of Europe. An instructive case has just been arranged in the museum to exhibit some of the most extreme types of domesticated sheep. The exhibits include the above-mentioned hairy breed, the fat-rumped Hedjaz sheep, the four-horned African, the spiral-horned Wallachian, the Scotch Mountain, the Leicester, and the Shropshire breeds.

DISCUSSION.

Mr. EDWIN RICHARDS (St. Vincent): I am opposed to the view of woolless sheep being the best to be grown in the West Indies. My view is that the woolly sheep is the best,

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*Further information in regard to this experiment is printed at the end of this paper. [Ed. *W. I. B.*]

because, in addition to the mutton, a considerable quantity of wool is obtained therefrom, which fetches a good price in the market. For instance, I have 300 woolly sheep on my farm, and last year I sold 2 bales of wool obtained from them: 1 bale, shipped in April, fetched 7¾*d*. per lb., and the other, shipped in October, realized 11*d*. per lb., and they netted together £20. The difference in price was no doubt due to the time of the year when they were placed on the market. We also have 1,100 sheep at Mustique. At Mustique where we pen 540 sheep, we sheared 2 bales of wool for the past year which gave 555 lb. of wool. Of this, 1 bale was shipped in the early part of the year, and sold in London, netting £6 9*s*. 5*d*., and weighing 228 lb.; the other bale has only just gone on and has not yet been accounted for, but ought to net more as it weighed 327 lb. At this farm the sheep are not sheared as regularly as at the farm in Bequia, hence the return of wool is not so large. I am of opinion that the woolly sheep are the best-paying animals, and having regard to the fact of the removal of the troops from the West Indies, the market for mutton will be confined, in a great measure, to our local wants, and should that be the case, the woolly sheep will pay better than the woolless. In addition to the wool, in 1903 we sold £45 worth of manure from the sheep housed at Mustique. If all the sheep were housed, the quantity of wool and manure obtained would be considerably greater. Therefore, in addition to the mutton and manure, we obtain from the other variety of sheep a good return for wool, which we would not get from the woolless or hairy variety.

Mr. E. M. DEFREITAS (Grenada): The main object of the sheep breeder is to put on the market a weighty, and withal, a sweet class of mutton. The Southdown, which best answers these requirements, does not thrive so well in the West Indies owing to the heat, which is rendered even more unbearable by reason of the mass of wool this species carries. On the other hand, we have in the African hairy sheep a species which seems peculiarly adapted to the tropics. The coat is of the red colour of the fox, short and hairy, showing no tendency to woolliness. The tail is shorter than that of the European species. In general, the legs and belly are of a black or brown colour. Its head is well formed and differs from the long, slender head of the African wild sheep. The peasants in Grenada have a somewhat quaint objection to this sheep. They look on one in their flocks as a 'black sheep,' thinking it a cross between a sheep and a goat. The great disadvantage of this species to the breeder is that at the age of twelve months it rarely attains a greater weight than 70 lb. Under these circumstances, a cross between these two species should combine the advantage of both with a minimum of the disadvantages of either. The question naturally arises: Is it better to cross between an imported ram and the native or the African hairy ewe, or with a native ram and an imported ewe? The objection to this latter cross is that the imported ewe, as stated above, is worried by the heat and her offspring is thus likely to be weakly. Further, experience teaches that, in all animals, better results are always

obtained by crossing the native female with the imported male. The aim should be gradually to 'grade up' the native female with the very best European males available, care, however, being taken not to 'over-grade.' Grading too highly is always a mistake, for the sheep, putting on fat rapidly, becomes either a shy breeder or totally barren. Likewise, the higher the grade the more wool, which, as we have seen, is very undesirable in the tropics. As to the best imported ram for our purpose, I have tried the Hampshire, the Leicestershire, the Shropshire, and the Southdown, and I unhesitatingly recommend the last-named. The species should be crossed either with the native or with the African hairy ewe. The weight of the cross-breed at twelve months runs up to 100 lb. The flavour of its mutton is better than that of the pure African sheep. It has a little wool, and, though not so marked as its mother, is a handsome sheep approximating the type of the Southdown. It is hardier than either parent and thrives well in the tropics. After a time, to regulate the grade, it is necessary to put on a native or a hairy ram instead of the Southdown, and in this way to 'grade' down, always maintaining the necessary balance.

ADDENDA.

The following letter has been received from the Hon. F. S. WIGLEY, St. Kitt's:—

As promised I send you a brief statement of my experience in sheep breeding at the Frigate Bay estate.

The estate is composed partly of hills covered with Acacia and low scrub, and partly of low-lying land open to the east and south to the sea, exposed consequently to the sea blast which plays freely across it.

My object when starting the breeding of sheep was threefold, viz., wool, meat, and manure. For the purpose of the wool I imported on various occasions rams from England and America, but, owing to the prevalence of a grass and shrub on the estate bearing a burr-like seed rendering the shearing difficult and the wool uncleanable, the breeding for wool had to be abandoned and the breeding of the woolly sheep altogether, they not thriving or fattening readily.

The sheep I now rear are of the 'woolless' or hairy breed common to the West Indies and best adapted to this climate for hardness, rapid maturity, and weight of carcass; average number, 500.

The sheep graze by day and are confined by night without food of any kind in a paved pen raised about 10 feet from the ground. This was originally the old mill ring; the pen is swept daily and the manure placed in a building away therefrom.

BARBADOS SHEEP.

Mr. G. M. ROMMEL, of the Bureau of Animal Industry, U. S. Department of Agriculture, has kindly forwarded for publication the following article on 'Barbados Sheep' written by him for the *Breeder's Gazette*:—

During a call at the Department of Agriculture in the fall of 1903, Sir Daniel Morris, K.C.M.G., Imperial Commissioner of Agriculture for the West Indies, directed the attention of officials of the Bureau of Animal Industry to the breed of woolless sheep which flourishes in Barbados and which is there highly esteemed for its mutton. The sheep are raised in Barbados and other parts of the West Indies, and are thought to be of African origin, although little definite information is available on this point. They are said to be very hardy and in dry districts profitable. They are not kept in large flocks in the island of Barbados, but, according to Sir Daniel, nearly every peasant proprietor in the drier districts around the coast has a few head. They are tethered to pegs while pasturing during the day, and are placed under cover at night. It was also stated that their habits were very much like those of the goat; they browse to a considerable extent and are thus very easy keepers. These recommendations seem to indicate that the introduction of this breed might prove useful to the farmers of States in the extreme south; accordingly, the Department opened negotiations for the purchase and importation of four ewes and one ram, which were successfully accomplished. The sheep were landed at New York on Saturday, July 9, and shipped to the Federal Quarantine Station at Athenia, N.J.

The writer was ordered to New York at once to examine and report upon them. The sheep were found to be in thin, but otherwise excellent, condition. Apparently they had been well handled during shipment and had stood the change nicely. The employés at the quarantine station reported that no ticks had been found on them and that the skin was apparently healthy.

This is a medium-sized, upstanding, fawn-coloured breed, practically without wool, and hornless or nearly so. In general appearance the sheep somewhat resemble at a distance diminutive hornless Jersey cattle or deer, the colour being exactly the shades of fawn seen in Jerseys except that the mouse-coloured fawn is not apparent. The sheep are decidedly 'leggy,' but have fairly deep bodies and quite well-sprung ribs. They appear to be hardy and of good constitution. There is fair width of back and loin, but a very deficient hindquarter. The rump is quite steep from the hips to the tailhead, and the tail is set very low. The thighs are 'cat-hammed;' there is little rotundity of buttocks, very little depth of twist, and the flesh is not carried down on the hocks as one sees in the best mutton breeds. The legs are generally quite well set and the sheep are active and lively. Ears are somewhat large and drooping, much like those of a Suffolk or Hampshire. There is also a slight tendency to a Roman nose, especially in the ram.

The colour of these sheep strikes one at first glance. This is either red or yellow fawn, marked with black which shades into brown on the hind quarters of one of the ewes. The black is confined to the inside of the ears, a spot on the poll, two spots on the forehead near the eyes and another below each eye, reaching to the lids. There is generally a spot on the top of the nose, which is black, and there is always black under the jaws running back at least as far as the angle of the jaws. In one ewe this is continued on the under side of the neck to the brisket in a rather broad line, where it joins the black of the belly, but in others the line is indistinct, missing, or displaced by a black spot near the jaws. The black colour spreads over the belly and the inside of the legs and reaches partly around the thighs, entirely up to the anus and on the under side of the tail, generally reaching to the extreme tip of the tail. It never spreads higher than the flanks on the body. In one case it fades into brown on the outside of the thighs. In the ram the legs below the knees and hocks are entirely black, and there is considerably more black on the head and black hairs on the top of the neck. In the ewes the fawn colour spreads down the outside of the legs somewhat evenly to the fetlocks. In the ewes also there are fawn-coloured hairs around the anus and vulva, which in one case form into a fawn-coloured band which extends to the udder. The teats in the ewes and the lower end of the scrotum in the ram are marked with fawn-coloured hairs.

The ears are peculiarly marked with a light, fawn-coloured line close to the outside edge and extending about two-thirds of the way around. They also generally have black hairs among the fawn-coloured ones on the outside, and a few fawn-coloured hairs near the head on the inside. The markings which seem to be constant are the black colouring of the belly, the inside of the ears and the poll, the spots on either side of the eyes, above the nose and under the jaws, the black line under the tail and the fawn-coloured line on the edge of the ears.

The body is covered with a thick, pliable, and generally soft skin which carries an abundant coat of coarse hair. The hair seemed coarser on the light-coloured sheep than on the darker ones. In three of the ewes there are traces of wool. One shows white wool fibres over the tops of the shoulder, over the crops and upper ribs and extending about half-way over the back. The second shows the same tendency but with a more limited area. The third shows brown wool fibres on the back and outside of the hind quarter, about half-way between the hock and the point of the buttock. The hair always lengthens in this part in all specimens. The ram has a decided beard which extends from the angle of the jaws almost to the brisket, at which latter point it is quite prominent. The colour of the beard is black, with a few brown hairs. The hair fibres are about $\frac{3}{4}$ inch long over the most of the body, increasing in length on the back of the hind quarter to as much as $1\frac{1}{2}$ inches. Where wool is present it is longer than the hair.

The skin is thicker over the upper part of the ribs than in other parts of the body and becomes thicker toward the tail, the difference on the rump being quite perceptible. In the ram loose skin (not folds, however) may be seen on the top of the neck.

The bone is rather large but generally clean. The ewes average a little over 75 lb., and the ram weighs 80 lb. They are yearlings.

Whether these sheep will prove valuable for mutton purposes remains to be seen. They will be carefully tested by the Department and their adaptability to southern conditions studied. It is thought that they may be useful in extreme southern parts of the country where a heavily woolled sheep may suffer on account of his covering.

TEACHING THE PRINCIPLES OF AGRICULTURE IN COLLEGES AND SCHOOLS IN THE WEST INDIES.

BARBADOS.

MR. HORACE DEIGHTON (Barbados): The few remarks I have to make will treat of the work done by the Imperial Department of Agriculture solely from an educational point of view.

Prior to 1892, the teaching of science at Harrison College, Barbados, was confined to chemistry, as up to that time the Island Professor of Chemistry, by whom the teaching was given, had to do all the work by himself with very limited time at his disposal. Mr. d'Albuquerque succeeded Mr. Harrison at Barbados in 1890, and in 1892 he was granted an assistant. Then matters were changed : additional accommodation was provided for science teaching at Harrison College: botany and elementary physics were added to the course, and since 1894 the classes have been annually examined by examiners appointed by the University of Cambridge, so that science was thus put on a firm and broad basis.

I have entered into these apparently irrelevant details to show that at Harrison College a considerable advance had been made in science teaching before the arrival of Sir Daniel Morris : because, had this not been the case, it is obvious that he would not have been able to offer, as he did in 1899, to provide a Lecturer in Agricultural Science, as that gentleman, instead of teaching agriculture would have been obliged to spend his time in teaching the rudiments of chemistry.

As it was, in 1899 Sir Daniel Morris provided a teacher of agricultural science to work under the direction of the Island Professor of Chemistry; and at Harrison College we at once set to work to take all the advantage possible of so liberal an appointment. The science curriculum was remodelled; two

hours a week instruction in science was given to each of the three lowest forms; longer hours were granted to boys of merit when they had reached a sufficiently high standard in general subjects, and candidates were prepared to compete for the Barbados Scholarship, which had hitherto been confined to classics and mathematics. I may also mention here that Sir Daniel Morris instituted some exhibitions to put a scientific education within the reach of boys who would otherwise have been unable to obtain one: a generous step which is already yielding good results.

No doubt, the direct object Sir Daniel Morris had in view in the provision he thus made for the teaching of agriculture was to turn out agriculturists with a sound scientific training, but incidentally other advantages accrued. A great impetus was given to the study of science, and the science department at Harrison College is now looked upon with very different eyes by both boys and parents from what was formerly the case. I may illustrate my point by referring to a boy named Cutting, who won the Barbados Scholarship in 1901. He entered St. John's College, Cambridge, where he obtained a Foundation Scholarship. He took a first-class in the Natural Science Tripos, Part I, 1903; was in the same year Wright's prizeman at St. John's College, and in the following year, 1904, he took a first-class in Botany in Part II of the Natural Science Tripos. It is true that Cutting entered the Science Class at Harrison College in 1896, three years before the appointment of the Lecturer in Agricultural Science, and was from the beginning a promising pupil, but his chances of success were greatly increased by the appointment of this Lecturer, owing to the longer time which the College staff could, during Cutting's last two years at Harrison College, devote to him.

For my part, I consider the action taken by Sir Daniel Morris in promoting the study of science is one of the greatest boons he has conferred on the West Indies. No thinking man can doubt that an agriculturist unequipped with a scientific training labours under serious disadvantages compared with his trained rival. It is not so much the mere knowledge of chemistry, botany, etc., which he has acquired in the laboratory—great as the value of this is—which will be of use to him; but the habit of mind and resourcefulness induced by his scientific training, the alertness and quickness of observation to which he may attain, will be found of the greatest possible service in the work of his life.

This is not the time or place to discuss the question of the teaching of science in schools; but many of the advocates of such teaching are, I am afraid, too apt to ignore what is regarded as absolutely essential by all educational authorities, viz., that an efficient general education is the necessary foundation for effective technical instruction; and that the best and most efficient technical instruction fails in its object, if the intelligence is not sufficiently developed to receive it.

At Harrison College, in addition to a sound general education, we can now, thanks in a great measure to Sir Daniel Morris, offer a thorough technical training in those subjects

which are of so much importance to the planter. The gain to the cause of education is evident. The comparatively speaking new direction along which the development of the intelligence may take place has, so to speak, been enlarged. From a purely educational point of view, this is the great assistance for which the thanks of the West Indies are due to the Imperial Department of Agriculture; and I venture to think that the indirect results of Sir Daniel Morris' action will prove educationally more important than the direct results.

There is another subject possessing considerable educational interest with which, unfortunately, I am not competent to deal, as my knowledge of it is entirely second-hand. I refer to the efforts made by Sir Daniel Morris to promote an intelligent interest in the cultivation of plants and vegetables among the peasantry by means of lectures to masters of primary schools, and by local Agricultural Exhibitions, which he is encouraging by offering prizes to peasant proprietors and others, including children at primary schools. I am informed by gentlemen who have interested themselves in the matter that these exhibitions are doing great good in Barbados, where they are arousing keen competition among the growers.

Professor J. P. D'ALBUQUERQUE (Barbados): At the West Indian Agricultural Conference of January 1899, I had the honour to read a paper entitled 'The Teaching of Agricultural Science at Colleges,' which appears in the *West Indian Bulletin* (Vol. I, p. 94).

I gave an account of the organization then existing for teaching natural science and agricultural science at Barbados, and put forward proposals, based upon the grant by the Imperial Department of Agriculture of a Lecturer in Agricultural Science, for a re-organization and extension of the existing course.

Towards the close of the same year, a lecturer under the Imperial grant was appointed, and the proposals outlined in the paper referred to were put into execution.

The educational position of Harrison College, its situation in the chief town, the existence there of spacious and well-equipped laboratories, and the fact that, encouraged by the Principal of the College, all previous work upon these lines had been carried out at that institution, rendered it obvious that any successful attempt to establish technical scientific education in Barbados must ultilize the existing resources of Harrison College.

The scheme, as a whole, comprised the teaching of very elementary natural sciences to the lower classes of the College, agricultural science to the agricultural science side of the College, and physics, chemistry, botany, and geology to candidates for the Barbados Scholarship.

The subject-scheme for agricultural science pupils involved the co-operation of Harrison College and its staff; such subjects as modern languages, mathematics, mechanics, and book-keeping being taken charge of by the Principal of the College and his staff, while the Island Professor of Chemistry was to be

responsible for the scientific side of the course; the Lecturer in Agricultural Science being placed under his direction for that purpose. The staff of the Science Department of Barbados, before the inauguration of the Imperial Department of Agriculture, consisted of the Island Professor of Chemistry and the Assistant Professor of Chemistry, only part of the time of each of these officers being available for teaching at Harrison College. To these was made the important addition of a Lecturer in Agricultural Science who devotes the whole of his time to teaching, and is a University man of high scientific attainments. This staff takes the whole of the science teaching mentioned in the preceding paragraph.

In Appendix I to this paper, I give a detailed syllabus of each of the scientific subjects of the course in agricultural sciences. Perhaps at a future Agricultural Conference it will be possible to discuss that syllabus, and so elicit valuable suggestions for improvement based on the wide scientific and educational experience brought together from the various parts of the West Indies.

I may here briefly state that the course occupies two years, and that in some cases three years are taken. The whole of each morning and also part of the afternoons are devoted to the science subjects. The following are the actual times per week devoted to the subjects mentioned :—

Agricultural chemistry lectures ...	2	hours for	1 year
Practical agricultural chemistry ...	4	„ „	2 years
Agricultural botany	2	„ „	1 year
Practical „	2	„ „	1 „
Agricultural physics	2	„ „	1 „
Physiology and entomology ..	2	„ „	1 „
Principles of agriculture ...	2	„ „	1 „
Technical tropical agriculture with cane planting and sugar manufacture	2	„ „	1 „
Practical sugar chemistry (analytical)	3	„ „	1 „

The pupils of each year are examined by the Cambridge University Examination Syndicate, who have appointed Dr. H. H. Cousins, late Professor of Agricultural Chemistry at Wye College and now Government Analytical and Agricultural Chemist in Jamaica, to take the more strictly West Indian technical subjects of the course.

Appendix II of this paper contains some of the recent reports of the examiners.

To those pupils that pass satisfactorily in all the subjects of the two years' course, a Diploma in Agricultural Science is awarded.

The average number of pupils attending the course is fourteen; the average age sixteen and a half years. During the past four years fifteen pupils have gained the Diploma in Agricultural Science.

In the practical chemistry course, pupils are taught to analyse manures, soils and feeding-stuffs; in the practical sugar

chemistry, they are taught all the ordinary analytical determinations necessary for a sugar factory. In this way an attempt is made to turn out young men who may be usefully employed as assistants in sugar factories as well as subordinates on plantations, and, as a matter of fact, some of those who have gained the diploma have been taken directly upon estates in Barbados upon my recommendation, and I have had subsequent applications from the same employers for further candidates for employment. I therefore have good reason to believe that pupils who establish a satisfactory record in these classes can readily obtain employment upon sugar plantations.

In 1900 the Imperial Department of Agriculture founded five agricultural exhibitions at Barbados, varying in value from £15 to £26 per annum, and two exhibitions were also founded, each of the annual value of £75, one for the Windward Islands, and one for the Leeward Islands, all of which are held at Harrison College. At the present time about half the class is composed of such exhibitioners. There can be no doubt that these exhibitions are a valuable part of the scheme, and enable a class of boys to benefit by the course who would otherwise be unable to attend—a class that is much more likely to make agriculture their life work than those who defray their own expenses.

A small proportion of the boys that have passed through the College classes in natural science and have taken the agricultural science course and passed with credit, are transferred to the Barbados Scholarship classes in physics, chemistry, botany, and geology. The Barbados Scholarship is of the annual value of £175 and tenable for four years at any British University. E. N. Cutting obtained the Barbados Scholarship in natural science in 1901 after six years' study in the science department at Harrison College, and during the last two years of his study there, enjoyed the benefit of the reorganized scheme of teaching. He proceeded to St. John's College, Cambridge, where he won a foundation scholarship and the Wright's prize, obtained double first-class honours in the Natural Science Tripos in 1903 and 1904, and is at present engaged in botanical research under Professor Marshall Ward.

At the present time, two of the natural science pupils at Harrison College are candidates for the Barbados Scholarship with good prospects of winning it in the near future; and one of these pupils is an agricultural exhibitioner who has obtained the Diploma in Agricultural Science and who owes his present chances of a future career to the exhibition awarded him by the Imperial Department of Agriculture.

In the foregoing account it will be seen that the Imperial Department of Agriculture has not attempted to supersede the agencies, which, provided by the Government of Barbados, had existed a considerable period prior to 1898. On the contrary, the Commissioner of Agriculture in this, as in all other possible cases, made full use of existing agencies which he wisely supplemented with valuable and efficient aid; and I venture to think that the results have been satisfactory.

In conclusion, I think it is due to the Principal of Harrison College to state that the above results could not have been attained, but for the fact that an institution of high educational standard was at hand, with the Principal who has raised the institution to that standard, and who was ready to give his countenance and lend his aid to any scheme which tended towards the improvement of education in the West Indies.

APPENDIX I.

COURSE IN AGRICULTURAL SCIENCE AT BARBADOS.

AGRICULTURAL CHEMISTRY.

The Atmosphere and the gases composing it.

Water, its chemical composition and properties. Rain water, river water, hard and soft waters, sea water.

Chemical Compounds important in Agriculture. The sources, preparation, and properties of nitric acid and the nitrates, sulphuric acid and the sulphates, hydrochloric acid and the chlorides, phosphoric acid and the phosphates, silica, silicic acid and the silicates; the oxides, hydrates, and salts of potassium, sodium, ammonium, calcium, magnesium, iron, aluminium.

Soils. Their origin, formation and chemical composition. The influence of earthworms on soil. The chemical and physical properties of sand, clay, chalk, and humus. Mechanical composition and mechanical analysis of soils. Classification of soils. The chemical and physical properties of soils of different kinds. The relations of air and water to soils. Nitrification and the biology of the soil. The chemical, physical, and biological effects of tillage operations and drainage. Chemical analysis of soils. Available and non-available supplies of plant food. Retention of soluble plant food by the soil. The constituents of plant food generally deficient in cultivated soils.

The Ash Constituents of Plants.

Manures. The supply of plant food by manure. The improvement of the soil by manuring. The classification of manures as regards their composition and nature. Farmyard manure and other natural manures. Composition of green manure, lime, marl, clay. Artificial manures, their origin and manufacture. The changes which manures undergo in the soil. The influence of drainage. The analysis and adulteration of manures. The chemical constituents of plants, fats, sugars, starch, nitrogenous substances. The composition and properties of milk, butter, and cheese.

Alcoholic fermentation.

Antiseptics.

BOTANY.

The division of the vegetable kingdom into flowering and flowerless plants.

Seeds of dicotyledons and monocotyledons. Albuminous and exalbuminous seeds. Seedlings.

The Root. The naked-eye and microscopic characters of roots. Secondary thickening of roots. Roots of monocotyledons and dicotyledons. Root-hairs and their work. The root nodules of leguminous plants and their agricultural significance. Nitragin. The various forms of adventitious and parasitic roots. Root storage. Roots used as food.

The Leaf. The morphology of the leaf, illustrated by common local examples. The microscopic structure of the leaf. Assimilation, respiration, and transpiration. Relations between animals and plants.

The Stem. The structure of typical dicotyledonous and monocotyledonous stems. Secondary thickening. Branching. The various forms of stem structures, e.g., underground stems, prostrate stems, suckers, tubers, bulbs, climbing and twining stems, illustrated by local examples. Stem storage. Stem as food. Layering, budding, grafting, inarching; the propagation of plants by cuttings. Healing of wounds.

The inflorescence and the flower. The structure and uses of flowers. Various modifications of the flower. Fertilization. The manner in which cross-fertilization is brought about. Adaptations of the flower to cross- and self-fertilization.

The formation of fruits and seeds and their description. The dissemination of seeds. Natural selection and artificial selection. Improvement of plants by selected seedlings, sports, bud varieties, and hybrids.

The Elements of Classification. The study of the following natural orders illustrated by specimens of West Indian agricultural and other plants:—Graminaceae, Palmaceae, Scitamineae, Leguminosae, Solanaceae, Convolvulaceae, Sterculiaceae, Rutaceae, Cucurbitaceae, Compositae, Euphorbiaceae.

The Elements of Plant Physiology. The physiology of nutrition. Composition of plants. Plant ash. Essential chemical constituents of plant food. Water culture. Assimilation, transpiration, and respiration. Carnivorous plants. The absorption and movement of water in plants. The physiology of growth and movement.

The General Characters of Fungi. Saprophytic and parasitic fungi. Life-histories of Torula and Mucor.

PRACTICAL CHEMISTRY. (1ST. YEAR.)

Preparation and properties of certain substances important in agriculture, viz., potassium chloride, potassium sulphate, and potassium nitrate; sodium nitrate; ammonium sulphate; superphosphate of lime; carbonate of lime.

Qualitative examination of simple salts for the following metals and acids :—

a. Metals :—Potassium, sodium, ammonium, magnesium, strontium, barium, calcium, zinc, aluminium, chromium, iron, nickel, cobalt, tin, antimony, arsenic, copper, mercury, lead, silver.

b. Acids :—Sulphates, sulphites, thiosulphates, carbonates, phosphates, borates, oxalates, hypochlorites, chlorates, chlorides, bromides, iodides, cyanides, nitrites, nitrates, acetates, tartrates, citrates, silicates.

PRACTICAL CHEMISTRY. (2ND. YEAR.)

The qualitative analysis of simple mixtures containing the following metals and acids :—

a. Metals :—Potassium, sodium, ammonium, magnesium, calcium, barium, strontium, zinc, aluminium, chromium, iron, tin, antimony, arsenic, copper, mercury, lead, silver.

b. Acids :—Sulphates, carbonates, phosphates, borates, oxalates, chlorides, nitrates, acetates, tartrates, citrates, silicates.

The elements of volumetric and gravimetric analysis as used in the estimation in simple solutions, simple salts or manures of nitrogen, chlorides, phosphoric acid, calcium, iron, and potash; free sulphuric, hydrochloric and acetic acids: free alkalies, hardness of water.

HEAT, LIGHT, AND METEOROLOGY.

HEAT.

Nature of Heat. Conservation of energy. Transformation of energy. Kinetic energy and potential energy, mechanical equivalent of heat. Joule's determination.

Temperature. Distinction between heat and temperature. Measurement of temperature. Thermometer scales. Method of making thermometers; maximum and minimum thermometers; the clinical thermometer; air thermometer, differential air thermometer. Absolute zero.

Effects of Heat. Expansion of solids in length, area, and volume. Absolute and apparent expansion. Expansion of liquids. The point of maximum density of water. Hope's experiment. Expansion of gases. Charles' law. Change of molecular state. Latent heat of liquefaction and vaporization. The boiling [point. Influence of pressure on the boiling point, and its application to vacuum-pan and multiple-effect evaporation in sugar factories.

Quantity of Heat. The unit of heat; specific heat; determination of specific heat; method of mixtures; ice calorimeter; heat capacity; water value; specific heat of gases at constant temperature and pressure; specific heat and atomic weight.

Hygrometry. The formation of dew. Daniell's and Regnault's hygrometers. The dew point.

Transference of Heat. Conduction, radiation, convection, nature of heat radiation. The best radiators are the best absorbers.

Combustion. Principles of combustion. Quantity of heat generated by combustion. Modes of transforming heat

of combustion into power in the steam engine, the gas engine, and oil engine.

LIGHT.

The nature of light. Light travels in straight lines. The formation of shadows. Eclipses. The action of a pin-hole camera. The laws of reflection of light. Formation of images in a plane mirror.

The laws of refraction of light. Total reflection. Refraction through a plate and through a prism. The action of a prism. Colour; composite nature of white light. The Spectrum. Spectra of the elements. Convex and concave lenses. The action of lenses. Formation of images by convex lenses.

An elementary study of the following optical instruments, their effects being traced by diagrams only: -telescopes, compound microscope, the spectroscope.

The polarization of light. The principles and mode of action of the polariscope.

METEOROLOGY.

The apparatus and methods of modern meteorology, thermometers, barometers, anemometers, hygrometers, apparatus for recording sunshine and making cloud observations. Rain gauges. Earth movements and earthquakes. The general motions of the atmosphere, winds, and trade winds. The secondary motions of the atmosphere. Cyclones.

ELEMENTS OF AGRICULTURAL PHYSIOLOGY AND ENTOMOLOGY.

Comparison of Skeletons of horse, ox, pig, and man in brief outline, showing main structural differences with special attention to limbs of horse and ox. The typical skeleton, bones, muscles, ligaments, tendons, and cartilages; their nature and functions. Nervous system, general arrangement and mode of action.

Food. General characters of albuminoids, fats, carbohydrates, salts and water: composition of milk: composition of animal body, dependence of animals on plants for complex food.

Alimentary Canal of rabbit and its appendages, viz., salivary glands, gastric glands, pancreas, intestinal glands. Comparison of the alimentary canal in the rabbit, horse, ruminant, and fowl. Digestion in the mouth, stomach, and small intestines. The liver, its blood supplies and functions.

Circulatory System. Blood and lymph, heart, arteries, veins, lymphatic system.

Excretion. Kidneys and skin; their structure and functions.

Lungs and respiration: Venous and arterial blood.

Nutrition. Daily loss and daily supply in the animal body.

Metabolism, composition, nutritive value, and digestibility of farm foods, albuminoid ratio. The chemical composition and use of the following foods used on the estates: oats, maize, sorghum, bran, linseed cake, cotton seed cake, grass, hay, ensilage. Relation of food to production of work, milk, meat, and manure.

Entomology. General characters and metamorphoses of insects, characteristics of the principal orders of insects illustrated by life-histories of insects injurious to West Indian crops and live stock. Recognition of common pests and their work.

Insects useful to agriculture.

Preventive and remedial measures. Insecticides and their composition, preparation and application.

PRINCIPLES OF AGRICULTURE (TROPICAL).

Agricultural Classification of Soils according to the proportions of clay, calcium carbonate, and humus.

IMPROVEMENT OF SOILS.

Principles of Drainage. Surface drainage. Under drainage. Essex system. Wedge and shoulder, plug drains.

Tile drainage. Size and make of tiles; how laid, distances apart and depth in different soils. Slope, angle of junction, relation between size of laterals and main drain. Silt basins: construction of outlet.

Chemical, biological and agricultural effect of drainage.

Irrigation. Catch-water and flow systems. *Irrigation by use of under-ground (pumped) water,* how arranged and carried out in cane cultivation. Volume of water required per acre, cost of. Advantage of irrigation in tropical agriculture.

Warping. *Use and value of Sewage.*

Tillage. Construction and use of common plough, digging plough, subsoil plough, double furrow, and multiple plough, turnwrest plough, American disc plough; cultivator, American disc cultivator, horse-hoe; harrow; roller. The operation of ploughing; distance of ridges in different soils. Forms of furrow slice. Subsoil ploughing, trench ploughing. Physical, chemical, biological, and agricultural effects of tillage and cultivation.

Clay burning, paring and burning, claying; liming, beneficial effects of, quantity used.

The Principles of Rotation of Crops. Two-, three-, and four-course rotations with simple examples; snatch crops. Leguminous green dressings.

The Preservation and Use of Farmyard Manure. Composition of 'pen manure' in the West Indies. Compost.

The Application of Farmyard Manure, and of nitrogenous, phosphatic, and potassic fertilizers in relation to climate, soil and crop.

The quantities used.

Grass Land. Principles of management in the tropics in relation to the below-specified grasses.

Pastures and meadows. Gramineous, leguminous, and miscellaneous herbage in grass land. Effects of manuring.

The cultivation of the following tropical grasses :—

Bahama	grass	(*Cynodon Dactylon*)
Guinea	„	(*Panicum maximum*)
Para	„	(*Panicum muticum*)
Sour	„	(*Andropogon pertusus*)

Haymaking and Ensilage.

Chief methods of Plant Propagation. Seeds. Germinative power. Selection of seeds. Seeding true; artificial cross-fertilization and selection.

Cuttings, bulbs, eyes. layering, grafting, budding.

Pruning, principles of.

TECHNICAL TROPICAL AGRICULTURE.

SECTION A. CANE PLANTING.

Botany of the Sugar-cane. Cane varieties. Seedlings, how raised, their advantages and disadvantages. Seedling experiments.

Climate and Soils. Preparation of land: its relation to rainfall, soil, and drainage. Depth of Barbados soil, proximity of limestone strata. Barbados subject to short periods of drought; the influence of the foregoing on methods of preparing land.

Planting the Cane, in rows, in stools; the use as seed cane and cane tops and pieces from plants or ratoons.

Manuring, cultivation and weeding, trashing, (i.e., spreading trash on land). Burning trash off land. Stripping (trash off canes). Ripening of cane; relation of arrowing to period of ripeness. Influence of arrowing on chemical composition. Leguminous snatch crops.

Chemical composition of the sugar-cane.

Diseases of sugar-cane. Insect pests. Life-histories of moth borer and of lady-bird borer. Fungoid pests. Life-histories of Trichosphaeria and Marasmius.

SECTION B. SUGAR MANUFACTURE.

Extraction of Juice. Cane mills, hydraulic attachment, maceration, diffusion.

Cane Juice. Composition, tempering, clarifying, scum, filter press, filter press cake.

Manufacture of Sugar. Inversion. Open-fire process. Steam pans. Muscovado sugar. Vacuum pan. Method of operating. Triple-effect. Centrifugals. Production of high-class sugars. Use of sulphur. Carbonation. Phosphoric acid process. Animal charcoal.

Saccharometers and their use. Molasses. Production, composition and uses. Recovery of sugar from molasses.

Fermentation. Nature of ferments. Conversion of sugar-cane into alcohol. Setting up wash. Yield of alcohol. Distillation. Forms of stills.

Section B. Watts' *Introductory Manual for Sugar Growers* (chapters v to x), has been used as a text-book for this *Section* of the course on Sugar.

SECTION C. OTHER CROPS.

Provision crops. Sweet potato, yam, eddoe, cassava.

Leguminous crops.

Export crops. Cotton, banana, onions.

SYLLABUS OF PRACTICAL SUGAR CHEMISTRY.

Estimation of saccharose (by direct polarization, by Clerget's inversion method, by inversion and Fehling or Soxhlet's methods); glucose and invert sugar (by Fehling and Soxhlet's methods), solids not sugar, and fibre in :—Cane juice, massecuits, sugar, molasses, cane, megass.

Use of Brix and Beaumé saccharometers.

Estimation of alcohol in spirits (by distillation and Tralles alcoholometer).

APPENDIX II.

COPY OF THE CAMBRIDGE EXAMINER'S REPORT FOR 1901.

HARRISON COLLEGE, BARBADOS.

To the Secretary of the Local Examinations and Lectures Syndicate of the University of Cambridge.

Sir,

I beg to present to you a report of my recent examination of the Harrison College, Barbados, in several branches of natural science.

A paper on practical chemistry was set to each of two divisions. In the case of the upper division the work consisted of fairly advanced qualitative and volumetric analysis, and in the case of the lower, of elementary qualitative analysis. I was pleased to find that these subjects had been most carefully and efficiently taught. The methods used, the results obtained, and the system and style of the written description of the work, were alike excellent in almost every case. I am convinced that the subject has been so taught as not only to make the candidates accurate analysts, but also to impart a sound knowledge of the scientific principles underlying the methods employed in the laboratory.

The theoretical paper on agricultural chemistry was again well done, and the marks obtained were uniformly high.

The answers to the paper on agricultural botany showed that this subject had been as efficiently taught and as

intelligently studied as that of chemistry. Almost all the questions were well done.

The least satisfactory work submitted to me was in agricultural physiology and entomology. The highest mark obtained was 79 per cent., a very creditable total to which several candidates approximated. But marks as low as 16 and 27 were awarded, and five of the papers failed to secure 'half marks.' One cannot, therefore, bestow upon the work in this department the same unqualified praise which that in the other subjects so well merited. I shall mention that, through a misunderstanding, I omitted to set a paper of questions in this subject, thinking it to have been included amongst the more technical subjects the examination of which was entrusted to another examiner. Such a paper was, however, set in Barbados by the Professor of Chemistry, and the answers were looked over and marked by myself.

The College is certainly to be congratulated upon the results of the examination ; it would seem to have been making rapid progress in standard and efficiency, and in supplying a training of the highest value in agricultural science.

I have, etc.,

(Sgd.) F. R. TENNANT, M.A.,
Gonville and Caius College, Cambridge.

REPORT ON EXAMINATION IN AGRICULTURAL SCIENCE, BARBADOS, DECEMBER 1903.

1. Six Students entered for this examination. The marks obtained on the whole work vary from a *maximum* of 83 per cent.—Bancroft—to a *minimum* of 46 per cent., with an *average* of 67 per cent. I mention this result as a striking proof that the higher standard of work I feel justified in asking for in this examination has been very adequately met both by the teaching staff and the taught.

2. A comparison of the work submitted by the class in 1901 with that sent in in 1903 is truly surprising. The subject is now no longer an ordinary school subject, strictly limited to mere text-book knowledge and practically devoid of technical value and insight. The papers sent in are, for the most part, of a high standard and display a technical, agricultural, and practical attitude that is highly creditable both to Professor d'Albuquerque, his staff, and the pupils.

3. As three years have now elapsed since I was first privileged to examine in agricultural science at Barbados, I may perhaps be permitted to express some opinion as to the progress of this work. The agricultural science course at Barbados is a branch of the secondary education at Harrison College: it might therefore seem, at first sight, unfair to expect any approach to a true technical standard of teaching under such conditions. I recognized, however, that in the Island Professor and his staff, with the reflected stimulus of the Imperial Department of Agriculture, Barbados possessed the requisite machinery for attaining a standard of high efficiency in the

teaching of agricultural principles specially focussed to the needs and circumstances of the colony.

4. I therefore deliberately set myself to establish a standard in these examinations that should raise 'Agriculture' from its well-merited contempt as a school or 'South Kensington' subject to a level capable of expressing some practical insight into the actualities of the local industry.

5. The results in 1902 encouraged me in this aim, and the outcome of this last examination has entirely justified the opinion I had formed. Without departing from the limits of the syllabus, questions were set involving agricultural *nous*, so as to elicit the information in the form in which alone such knowledge can be of use in practice. Had the class been taught on routine lines and from text-books only, the marks obtained would have been low. I am indeed pleased and proud to be able to record that, in the majority of cases, the questions were treated in a style and spirit deserving of all praise. These results must be recognized as an undeniable proof that the work at Barbados is not only educational, but it is also imbued with that technical and practical spirit which is necessary if agricultural science is to be taught to any adequate purpose.

6. The practical work in sugar chemistry showed a fairly uniform competence in the performance of the standard methods of sugar analysis involved in modern factory control.

(Sgd.) HERBERT H. COUSINS, M.A., F.C.S.,
Island Chemist for Jamaica.

DISCUSSION.

Mr. WILLIAM BURSLEM (Trinidad): I should like to ask whether at Harrison College the boys in the science department take part in the ordinary work of the school, or do they study only agricultural science? When does a boy specialize in agricultural science?

Professor d'ALBUQUERQUE (Barbados): All the boys take part in the ordinary work of the college. The first four forms receive each two hours' instruction in agricultural science; but boys in the fourth and fifth forms, specializing in agricultural science, are excused for the greater portion of other school subjects.

The PRESIDENT: The point aimed at in introducing agricultural science into the higher-grade schools is that each boy must have a good, sound, general education as a foundation, and Mr. Deighton has adopted that from the beginning. A boy at Harrison College cannot specialize in agriculture until he has reached the fourth form, and careful inquiry is made beforehand whether he proposes to take up agriculture as a means of livelihood. Similarly with boys who win scholarships, it is required from the parents to give an assurance that the boy intends to pursue an agricultural career. But all along we insist that that boy's general education should

not be neglected. When the matter was brought before the Conference in 1899, I then stated that the Secretary of State for the Colonies had approved of the proposals for offering agricultural instruction to Jamaica, Barbados, and Trinidad. At that time Trinidad was not in a position to accept the offer, and other arrangements were made in order to utilize the grant. The other two colonies accepted the offer, and the work has been steadily carried on ever since.

LEEWARD ISLANDS.

Dr. FRANCIS WATTS (Leeward Islands): Owing to the help afforded by the Imperial Department of Agriculture there are now science masters attached to two of the Grammar Schools in the Leeward Islands, one in Antigua and the other in St. Kitt's. An attempt is made to offer to the boys, at a comparatively early period of their career, a choice of the kind of education which they wish to receive. Many boys in the Antigua Grammar School received in the past a purely classical education of a high type, which did not, in the opinion of many of us, exactly fit them for the agricultural life which most of them had to pursue. The plan now adopted is to offer an opportunity to the boy to decide whether he will include scientific teaching in his curriculum or will remain on the classical side. What we aim at is secondary education with an agricultural bent, so as to produce in the people that *habit of mind* which Mr. Deighton has recognized as the all-important thing in agricultural knowledge. It is not so important that the boy should learn to perform certain operations at an early age, as that his mind should be directed along certain lines of thought. There appear to be different bents of mind—the classical, the legal, and the scientific. We wish to introduce into the secondary and elementary schools the trend of mind which we call scientific. In our system of agricultural teaching we can, at an early stage in a boy's career, direct his attention to the various experiments which are being conducted at our experiment stations, and that without being unduly technical. We can thus institute that connexion between book work and practical work which will prove infinitely useful in after years. Thus, being taught how to utilize books, he will go on adding to his knowledge to the end of his days. There is a common, though decreasing, tendency for a boy to regard books as the appendages of school, to be cast aside as soon as he begins what he regards as his life-work. Our idea is that the boys should recognize that books are life's working tools, fostering and maintaining that scientific habit of mind essential to successful agriculture.

There seems to be one difficulty which might be got over as time goes on; that is the position of the overseer in the Leeward Islands. This is a subordinate officer on our estates, the senior being known as manager. In Jamaica the senior is called overseer, and the junior book-keeper. Our overseers, unfortunately, do not occupy a sufficiently good position as members of the planting class. As planting in its various branches is the profession which most of our boys have to

follow, we desire to bring the pressure of public opinion to bear on the employers of these young men in order that, when they get well-equipped and decently trained boys from school, they should give them better positions and better pay than many overseers now receive. That can, I think, be accomplished by personal effort and attempts to influence public opinion. It is wrong that a boy, who has been working hard, trying to acquire knowledge and habits of thought which will advance him in life, should be thrown into associations, which, except he is a youth of a high character, will tend to drag him downwards. I look forward with some degree of assurance to the time when the improved condition of our sugar industry, the introduction of new industries, such as the cultivation of fruit and the growing of cotton, will create a demand for better-trained men, and raise the status of overseers.

In addition to secondary education, we have to consider primary education, and much is being done to introduce agricultural ideas into the elementary schools.

In Dominica there exists another form of education which does not occur in Barbados; it occurs also at St. Vincent and St. Lucia: that is, an attempt to educate the sons of the peasantry in definite, technical, practical agriculture of a secondary type. I refer to Agricultural Schools. That in Dominica is doing better work than was anticipated. The boys receive some elementary education and are trained, as far as possible, to till the soil; they are actually educated in agricultural work based on good sound lines in connexion with the schools and the Botanic Stations where good work is carried on. The Dominica Agricultural School differs entirely in the kind of teaching from that given in the Grammar Schools at Antigua and St. Kitt's. The school is of a technical character, aiming at teaching the boys the rudimentary arts of agriculture, at the same time taking care that they have a sufficiently sound knowledge of reading, writing, and arithmetic, essential to persons of the class dealt with.

JAMAICA AND BRITISH GUIANA.

The PRESIDENT: In the ordinary course I should have liked to receive a statement of the educational work, both secondary and primary, that is being carried on at Jamaica; but we have no opportunity for it this morning. The work there has been prosecuted on successful lines for several years, and I am glad to say the results have been just as encouraging as in other parts of the West Indies.

Mr. E. W. F. ENGLISH (British Guiana): The science work at the Queen's College has, so far, been of a purely scientific character. The teaching of science is carried on throughout the whole school; the higher classes receive some three hours' theoretical work and four hours' practical work; the lower classes receive two hours' instruction in elementary science by one of the assistants at the Government Laboratory. Certain of the boys have also attended lectures delivered to school masters.

TRINIDAD.

Professor P. CARMODY (Trinidad): It has been decided to take the first step this year in introducing higher agricultural education among the courses of instruction given to the students of the Queen's Royal and St. Mary's Colleges.

The paper prepared by the Inspector of Schools on 'School Gardens and School Shows in Trinidad' indicates the present stage of agricultural education in the primary schools of the colony. It has so far advanced, since its introduction a few years ago into these schools, that unless some steps were taken we should soon be in the undesirable position of witnessing an educated labouring class working under the guidance of less educated (in that particular subject) employers, or their managers and overseers. To avoid this position, which would be as unfortunate as humiliating, it had become necessary that students attending the colleges should be given facilities for studying this subject more thoroughly than is now afforded for the teaching of elementary agriculture to the students in the primary schools.

The question of introducing higher agricultural education here has been long under consideration; but it has always been evident that an Agricultural College is at present an impracticable scheme. It was only when the Cambridge Local Examiners included agricultural science in their programme, and adapted the examination to these colonies' requirements, that the proposal which I subsequently made suggested itself. The proposal was to substitute agricultural science for advanced chemistry now taught to the senior students, as in this way it could be introduced with very little extra cost to the Government. It was a more suitable subject in a purely agricultural colony, and, being connected with things familiar to them, would be more interesting and attractive. My proposal was accepted by the Principals of the colleges concerned, with a modification, which, though involving more labour, is a distinct improvement; for with this modification the students will have an opportunity of studying agricultural science and kindred subjects for at least four years, instead of the shorter period I had proposed. The following is the report of the committee consisting of the Principals of the three colleges and myself:—

'The committee nominated by the College Council on July 7 last, to discuss and formulate a scheme in respect to the proposed teaching of agricultural science at the colleges, have the honour to report that they have unanimously agreed to make the following recommendations effecting a change in the curriculum so far as the subject of chemistry is concerned:—

(a)—That elementary agricultural science should be taught at the Laboratory one hour a week during term time to boys of class IV.

(b)—That the boys of class III should receive one lesson a week for one hour in agricultural science, and one lesson a week for one hour in theoretical chemistry.

(c)—That theoretical and practical chemistry should form the subjects of two lessons of one hour and a half per week for boys of class II.

(d)—That two lessons in agricultural science of two hours per week should be given to boys of class I.

'Hitherto, classes I and II only have attended at the laboratory, and the instruction given has been confined to theoretical and practical chemistry.

September 21, 1904.'

So far as it can be outlined at present, the course of instruction for the first year will be similar to, but more detailed than, that previously given to teachers of the primary schools; in the second year agricultural instruction will be of a more advanced nature and will be supplemented by instruction in correlated sciences; in the third year the present junior chemistry course (theoretical and practical) for the Cambridge Local Examination will be taken; and in the fourth year a still more advanced course of agriculture. Practical demonstration will form an important part of each course, and during the four years we shall endeavour to include every branch of the subject that may be of local as well as general utility.

The senior or fourth year's course will practically be limited to the subjects specified in the examination programme which is appended. This has very wisely been modified to suit colonial students; but the kind of examination which will lead to the best practical results in the long run is one in which useful work of any kind actually done by students during the year and set out in their note-books will receive a due share of credit. This work should be left to the choice of the teacher or, in some cases, of the student. In this way the instruction could be adapted to particular local requirements, for even in these colonies these requirements vary to a considerable extent.

No programme of examination for students of the first and second years has yet been drawn up: but when this is being done it would be advisable to include note-books for the purpose and in the manner already suggested. A written examination, extending over one or two hours, is not a satisfactory test for agricultural instruction, which in order to be of lasting benefit must adapt itself closely to local requirements.

This is a brief outline of our present scheme of which I hope to be able to report good results at some future time.

It will not be out of place here if I state that two other attempts have been made to introduce higher agricultural education. At the Government Laboratory, for many years past, students have been admitted on payment of a nominal fee, to cover the cost of apparatus, for practical instruction in the analysis of soils, manures, sugar, cane juice, molasses, etc. This course of instruction has proved very attractive. but had latterly to be discontinued owing to pressure of other work. It is such a course as this that I wish to see included in the note-book part of the examination of the more advanced students.

At the Victoria Institute, a series of lectures in agricultural

botany was given, of which the following is an outline. I regret to say that the attendance was not sufficient to justify the continuance of this course:—

SYLLABUS.

Theoretical.	Practical.
1. Seeds.	How to sow seeds.
2. Germination.	The treatment of seedlings.
3. Roots.	The preparation of the soil.
4. Root or hypogeal growth.	How to feed plants.
5. Stems.	How to transplant.
6. Stem or epigeal growth.	Principles of pruning.
7. Leaves.	How and when to apply water.
8. Functions of leaves.	Propagation by division, cuttings, and leaves.
9. Flowers.	Propagation by inarching, grafting, and budding.
10. Functions of flowers.	Crossing and hybridizing.
11. Fruit.	Causes and cures for ill-health among plants. (a)
12. How plants are classed and named.	Causes and cures for ill-health among plants. (b)

Fee for course of three months—2*s.* 6*d.*

The following is the Cambridge Local Examination programme in agricultural science (Seniors):—

PAPER I.

Candidates will be expected to show, by their answers, that they have acquired practical knowledge, by their own observations and by experiments, of the following subjects:—

The ultimate composition of plants—carbon, hydrogen, oxygen, nitrogen, phosphorous, sulphur, chlorine, potassium, sodium, calcium, magnesium, iron, silicon. The chemistry of these elements and their simpler compounds, their detection in plants, and in soil. Water and sand cultures.

The structure, arrangement, and functions of leaves. The structure and functions of roots and stems, with their chief modifications.

The soil as a source of plant food, its mechanical and chemical composition, and its relation to the supply of water and heat to plants. The absorption of food from the soil; osmosis, capillarity, transpiration.

The structure and functions of the flower and its various parts. Pollination and fertilization. The development, structure, and dispersal of fruits and seeds. The germination of seeds, and the utilization of their reserve stores. Translocation of food-stuffs. Propagation by vegetative methods.

Candidates will be expected to have a general knowledge of the useful and harmful plants in the following natural orders:—Cruciferae, Rosaceae, Leguminosae, Chenopodiaceae, Polygonaceae, Solanaceae, Labiatae, Gramineae.

[For the above-mentioned natural orders, candidates at

colonial centres may substitute the following: Gramineae, Palmaceae, Scitamineae, Leguminosae, Solanaceae, Euphorbiaceae, Rutaceae, Malvaceae.]

Paper II.

The formation and properties of soil. The agricultural characteristics of typical soils. The amelioration and improvement of soil. The properties and uses of important manures. The principles of rotations. The employment and purpose of implements used in cultivation. Farm crops in their relation to soil, manure, cultivation, harvesting, disease, and insect injury. [For farm crops, candidates at colonial centres may substitute sugar, cacao, coffee, tobacco, cocoa-nut, banana, orange and lime, pine-apple, arrowroot, sweet potato.] Permanent grass-land, its formation and management. [For permanent grass-land, candidates at colonial centres may substitute Bahama grass (*Cynodon Dactylon*), Guinea grass (*Panicum maximum*), Para grass (*Panicum muticum*), sour grass (*Andropogon pertusus*).] The characteristics of common farm weeds.

The distribution and characteristic features of the more important breeds of farm stock. [For this, candidates at colonial centres may substitute the following: The alimentary canal and its appendages; comparison of the alimentary canal in the rabbit, horse, ruminant, and fowl; digestion in the mouth, stomach, and intestine.] The feeding of farm animals, and the compounding of typical rations.

The President: Has a Lecturer in Agricultural Science been appointed?

Professor Carmody: Yes.

The President: That I am glad to learn, for it completes the appointment of Lecturers in Agricultural Science throughout the West Indies. What I would like now to see is a science teacher attached to all the Grammar Schools. There are Grammar Schools at Dominica, St. Vincent, and Grenada, and a good private secondary school at St. Lucia. Boys from the latter have on two occasions won the agricultural scholarships offered for the Windward Islands. It is hoped to extend the usefulness of these institutions by providing the means for teaching elementary science and agriculture. In the meantime it is very satisfactory to learn, although it has taken six years to carry it through, that we have at the colleges at Barbados, Jamaica, British Guiana, and Trinidad, competent men engaged in teaching the principles of agricultural science, and that a beginning has also been made in teaching agriculture in the Grammar Schools.

SCHOOL GARDENS AND SCHOOL SHOWS IN TRINIDAD.

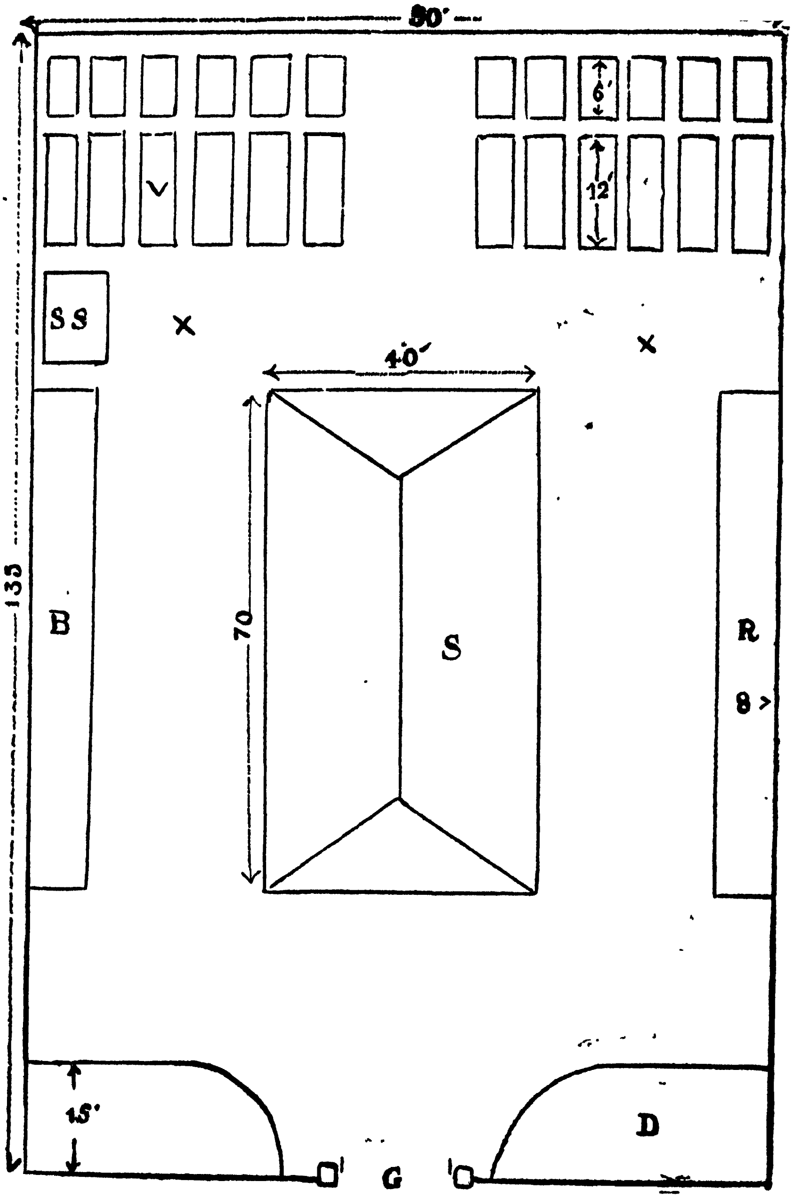
BY J. H. COLLENS,

Inspector of Schools, Trinidad.

In presenting to you a few desultory notes on school gardens, I lay no claim to originality, and still less to scientific knowledge of my subject. My own personal inclination for gardening pursuits has always been followed up in truly amateurish fashion, and whatever slight experience I may have gained in the cultivation of vegetables, fruits, or flowers, has been at the cost of the not infrequent disappointments and failures attendant upon an ignorance at the outset of many of those elementary principles of agriculture which we are now striving to make familiar to every fifth-standard boy in our schools. Half a century ago the 'three Rs,' with a smattering of geography and grammar, comprised the curriculum in English primary schools. Then came the craze for extra subjects, and sundry 'Ologies' were added, to be crammed merely from books; but it was not till well on in the nineteenth century that legislators began thoroughly to realize the fact that, in the great industrial struggle for pre-eminence among nations, that nation must inevitably come most prominently to the front, which most carefully and judiciously educates its young. The importance of establishing good technical schools in large manufacturing and commercial centres had long been recognized, but, strange to say, the anomaly of teaching almost every subject except agriculture, in a purely agricultural country, had not made itself apparent. This is now altered; there has been an awakening, and following modestly in the wake of the great nations of Europe and America, we in the West Indies are endeavouring to place agriculture on its proper footing in our schools. One of the best means by which we can open out the great book of nature with its fascinating stories, pictures, and realities to the young mind, is to have a school garden.

SCHOOL GARDENS.

The school garden should comprise two sections, one for experimental or educational work, pure and simple, the other for the production of ordinary vegetables and flowers. If sufficient land be available, the senior lads might be entrusted with the care of a small plot, which they should themselves prepare, doing all the digging, sowing, planting, weeding, hoeing, etc. It might be useful to allow each a younger pupil as an assistant; the junior will thus be learning lessons which may be of service to him when he shall have arrived at the dignity of being the holder of a similar plot. Gardening operations should always be conducted under careful supervision; these outdoor lessons must not be of such length as to be wearisome. Three quarters of an hour at a time is quite long enough, and if the work of the day be of an especially



PLAN OF SCHOOL GARDEN.

S.—School.
G.—Gate.
D.—Decorative Section.
B.—Borders for Miscellaneous Plants.
X.—Position for small Shade Trees.

V.—Vegetable Beds.
SS.—Seed Sheds.

laborious character, such as digging or forking, it should be undertaken in spells of three or four boys at each spell.

The plants to be cultivated must, of course, depend upon a variety of circumstances—the amount of available ground, the nature of the soil, the season of the year, etc. It would be absurd to lay down any hard and fast rule with regard to the size of the beds, but I have here a plan of a school garden as suggested by Mr. Leslie, the senior Agricultural Instructor of this colony.

It deals with an area of about 400 square yards, which may seem, possibly, more than some schools could undertake to keep in order, but, excluding the ornamental portion where the shrubs and flowering plants will not make any great demand upon the time and attention of the pupils, there remains an area of only 200 square yards, divided into a double series of beds of two sizes. The smaller beds are naturally intended for plants occupying but little space, the larger ones for such as require more room for expansion. Mr. Leslie, in the pamphlet from which I have taken this plan, gives a list of the plants most suitable for each kind of bed. A copy of this pamphlet has been forwarded to every school in the colony which has a garden.

Any attempt to teach gardening, without devoting a portion of the land to purely experimental work, will fall far short of the object to be attained. One half of the garden should be kept for purposes of instruction only, and of these beds so reserved (no matter what the plant under cultivation) one-third of the soil should be thoroughly forked and well manured, another third forked only, and the remaining third neither forked nor manured. It is important that the pupils be taught carefully to observe the results in each case, and note them down in their note-books for future reference. I have here a sample of some notes which have been furnished by schools in Naparima and Savana Grande to the Inspector of that district:—

CANAAN CANADIAN MISSION SCHOOL—1904.

Class.	Number of holes.	Age.	Weight. in pounds
Canes.			
Holes only	3	9 months.	24
Holes, forked	3	9 „	81
Holes, forked and manured	3	9 „	180
Tannias.			
Holes	6	9 „	1¾
Holes, forked	6	9 „	12½
Holes, forked and manured	6	9 „	29½

MOUNT PLEASANT GOVERNMENT SCHOOL (clay soil)—1904.

Number of holes.		Age.	Weight in pounds.
Yams.			
Hole only	1	8 months.	5
Hole, forked	1	8 ,,	8
Hole, forked and manured	1	8 ,,	29

Where teachers adopt these methods, the out-door work becomes a continuous object-lesson, supplementing and materially aiding the oral instruction imparted within the four walls of the school-room. The collective lessons in class must fit in and harmonize with the more practical ones given in the uncovered school. Blackie's *Tropical Readers* form a good and simple basis for them, and they are required by our code to be used in the schools from standard iii. upwards. The students of the training schools use as their text-books Dr. Watts' *Nature Teaching*, Dr. Nicholls' *Tropical Agriculture*, and Johnston's *Catechism of Agricultural Chemistry*. In the purely practical, as distinct from experimental, work we have found some of the pamphlets issued by the Imperial Department exceedingly helpful, notably 'Hints on School Gardens,' and 'Cultivation of Vegetables in Barbados.' Time will not permit, nor is it necessary, that I should enlarge upon the advantage of familiarity with such processes as budding, grafting, layering, pruning, etc., or an acquaintance with the nature and compositions of soils, the use of manures, the most effectual methods of dealing with insect pests and diseases of plants. The bearing which a wider knowledge of these may have upon the future trade, commerce, and therefore prosperity, of the West Indies is hardly sufficiently realized, but I believe that the day is not far distant when we shall see in our local markets a great improvement both in the quality and the quantity of our fruits and vegetables, and it is not too much to hope that our primary schools may be a humble factor in accomplishing this. We are not doing much perhaps, and may be doing that little imperfectly, but we are honestly endeavouring, according to our lights, to give the younger generation that form of education which will go to the making of good citizens and good men.

SCHOOL SHOWS.

In Trinidad the efforts of our elementary teachers in the direction of practical agriculture have been stimulated in various ways: by courses of lectures given by Professor Carmody and Mr. Hart; by occasional visits of the Agricultural

Instructors to school-gardens, to give advice and instruction; by the gratuitous distribution of useful literature, such as the *Agricultural News*, the *Bulletin* of the Botanical Department, the *Proceedings* of the Agricultural Society, and last (though not least) by a bonus award based upon the Inspector's Annual Report on the year's work in the school garden. I have referred to these as stimulants to the teacher, but it must be admitted that they have also directly or indirectly had their influence upon the pupils. That, however, which, more than anything else, has helped to make school gardening popular, is the annual vegetable show. It has aroused a spirit of emulation and rivalry, which, if not the highest motive, is, at any rate, one that serves its purpose.

Beginning in a small way, our first school exhibition was held at Port-of-Spain on January 9, 1902, when forty-two schools competed, sending 293 exhibits. It was at once seen that greater benefit would be derived by holding these shows in the heart of the agricultural districts, and, accordingly, next year Port-of-Spain was forsaken, and local shows were held at Couva, Tunapuna, and Princes' Town. In the following year the Tobago schools entered into the competition with Scarborough as their centre. Each year the increased number of schools taking part and the improved quality of the exhibits have been a convincing proof of the utility of these annual exhibitions. At the four shows held in November and December last, 122 schools contributed over 2,500 exhibits. In addition to vegetables, fruits, and flowers, schools are encouraged to send products of their own manufacture such as chocolate, starch, oils, cord, brooms, fishing nets, baskets, bees'-wax, honey, specimens of carpentry, etc. Girls also are allowed to exhibit garments and samples of needlework prepared in accordance with the requirements of the code, and we hope some day to be able also to include such items as jams, jellies, cakes, etc. The prizes, though small in value, varying from 4*s*. to 1*s*., aggregate to a total at each centre of from £15 to £16, this amount being provided from one of the education votes, which also meets the expenses connected with the organization of the shows. Strict economy being observed, this expenditure is kept down as much as possible, so that it seldom exceeds £5 or £6 at each show. A Silver Challenge Medal is given by the Agricultural Society of Trinidad and Tobago, to be held for twelve months by the school considered to have sent in the best all-round exhibits for the year. Couva Government School was the first winner of this medal in November 1903, and it has just been won at the recent shows by Carenage Government School, where, in spite of being handicapped by a poor, sandy soil, the head teacher for four successive years has sent in creditable exhibits. At the 1904 shows, a new feature was the addition of a section of exhibits from peasant proprietors, the Agricultural Society's vote of $200, with local subscriptions, furnishing the prize money. Schools were allowed to compete in this section, and in several instances did so with success. The railway authorities convey exhibits, to and from the place of exhibition, free of charge, and issue return tickets to teachers and pupils at reduced rates. While

the Education Department exercises a general control over the shows, the arrangements for each are generally made, and I may say efficiently carried out, by local committees, with the Warden of the district as chairman, and it must be acknowleged that the success of these shows in the past in this colony is largely due to the very ready assistance afforded by other government departments, by the local committees, and by the Agricultural Society.

The Rev. Dr. MORTON (Trinidad): As manager of a large number of schools, almost all of which are East Indian, I can say that the institution of school gardens and school shows has been of great advantage to the other parts of education. In this hot country schools have a tendency to become dull and dreary. We meet that by giving recess and work in gardens, and the work of the smaller children in gardens has met with better success than any recess that could be given. Very small children like to plant things and to see something planted: the child who takes its toy to pieces to see how the wheels work is the boy who later on wants to know how the peas grow. In school gardens we get the bent of the mind at an earlier age in the right direction, and there is now very little difficulty experienced here in getting the children to take to the cultivation of the soil. Nothing is lost in the training of the children in the 'three Rs' by the little time that is taken from the latter in teaching them agriculture.

The PRESIDENT: I regard teaching the principles of agriculture as fundamental in regard to the future of these colonies: hence the Imperial Department of Agriculture has done all in its power to further the movement. I believe more real progress will be achieved in this direction than in any other way.

Mr. COLLENS: I should like to supplement my paper by making this remark. The progress which agricultural education has made in the West Indies is due to the fact that it has been so consistently advocated by the Imperial Department of Agriculture. At each Conference held under the auspices of the Department, the question has been very pointedly brought forward; and it is to this fact, together with the advantage we have gained by mixing with one another and the interchange of thought, that has made the task a less difficult one.

AGRICULTURE IN THE ELEMENTARY SCHOOLS OF GRENADA AND ST. VINCENT, 1902-4.

BY JOHN HARBIN,

Inspector of Schools, Grenada and St. Vincent.

For the purposes of this statement, it has been found convenient to treat these two islands as a whole, the circumstances connected with their efforts to advance agricultural education being largely similar and, in point of time, practically co-existent.

At the time of holding the last West Indian Agricultural Conference in January 1902, the elementary school teachers of these two colonies had not yet gone through the full preparatory course necessary for fitting them for their new duties of teaching agriculture as a subject wider in its range than the mere imparting of a certain amount of theory acquired anyhow. At St. Vincent, a complete series of lectures had been delivered to the teachers ; but at Grenada, owing to quarantine restrictions and other external causes, the third and last course of lectures and demonstrations necessary to complete the series arranged under the auspices of the Imperial Department of Agriculture was not delivered until August 1903. The results then, as on previous occasions, were satisfactory ; and immediately after, the laying out and enclosing of school gardens was undertaken seriously by the Board of Education out of funds specially voted for the purpose.

The further plan suggested by the Imperial Commissioner of Agriculture, of amplifying the series of lectures thus delivered, by means of Saturday courses to be undertaken at different centres in the islands by the Curators of the Botanic Stations and the Agricultural Instructors, had to be abandoned in Grenada, owing, firstly, to the prolonged illness of the Agricultural Instructor (Mr. Murdo McNeill), which resulted in his resignation of office; and, secondly, to the unsettled or suspended condition of the Agricultural Department for the greater part of this year through the vacancies in office of both the Agricultural Instructor and the officer-in-charge of the Botanic Station. At St. Vincent, on the other hand, arrangements had been made, as recently as October last, for proceeding with the series similarly organized, to be undertaken by the local officers there.

At the end of 1903, at Grenada, and on June 30, 1904, at St. Vincent, thirteen and six school gardens, respectively, had been laid out and enclosed. Thus it will be seen that of the seventy-two schools under my inspectorate, twenty-five possessed school plots six months ago, while the Botanic Stations and certain plots, under the control of the Imperial Department of Agriculture in out-districts in both islands, are available for the pupils of any schools in their vicinity whose managers care to make definite arrangements for having the use of them. This outline, in comparison with what can be shown in other colonies, may seem meagre, furnishing evidence of only slight advancement ; but, it must be remembered

that it represents entirely new work since the date of the last Conference: further, when the trying period experienced by St. Vincent in the interim is borne in mind, the position indicated is by no means such discouraging reading as might at first glance appear.

The school gardens have all been laid out and enclosed on the lines laid down by the Commissioner. The footpaths, originally well defined, have been so maintained, and in several instances improved by the application of macadam; and the inner and outer hedges recommended have been, here and there, well established and have amply served their purpose as a protection against damage by poultry and small stock. The red-painted, lath fencing held together by strands of wire four rows deep, recommended by the Imperial Commissioner, is in use in Grenada, and serves well the purpose for which it is used. It is, however, open to question whether an outer *and* an inner hedge grown together do not collect too much water, and so tend to destroy the wooden fencing prematurely. These enclosures thus painted are more attractive in appearance when unhidden by the outer hedge, and invite occasional visits from the parents of pupils. The gardens, if well kept on the system of encouraging competition by making every two or three boys responsible for a particular bed, serve as object-lessons to the peasantry of what their children are capable of doing, thus dispelling much of the aversion to manual labour which, until recently, has been so pronounced an obstacle to the successful pursuit of agriculture.

In St. Vincent, the enclosures, being of galvanized wire, are by no means attractive in appearance. I am, however, inclined to the opinion that the want of attractiveness in the St. Vincent school plots will be no hindrance to their success. The areas of the plots in the two islands vary between ⅛ acre and ¼ acre each. The thirteen Grenada plots cost £170. which includes the cost of drainage in some instances preparatory to enclosing.

I cannot do better than quote an extract from my St. Vincent annual report for 1903-4 to show what has been the scope of the work that was done in one of the best schools during the school year. It is as follows:—'The pupils gave practical demonstration of their knowledge of the theory taught them by the ease and familiarity with which they dissected and removed the several parts of bean seeds. unpotted plants and understood their re-potting, and answered questions particularly relating to soils and drainage, together with various other tests undergone by them. On the whole, first principles were well and carefully taught in all the schools offering this subject.' In Grenada, the results have been equally good, as a rule, though in some instances better, through covering a wider range of work; and five, at least, of those schools with gardens, examined within the last three months, have accounted satisfactorily for the time and teaching devoted to them.

The introduction of this subject on its practical side into the school courses has not been without obstacles in Grenada, for as recently as six months ago, the manager of a school in the capital requested the Board of Education to allow him to hand

back to that body a plot most conveniently situated in the town, and one that had been properly cleared and enclosed with two others adjoining it at the expense of the Government in the first instance. His request was granted, and the lot abandoned by him has since been handed over by the Board of Education, by request, to another school manager who has never experienced any difficulty in getting the pupils of his school to cultivate their plot. In St. Vincent I have had no similar experience.

In the five schools above referred to the pupils examined at the recent annual inspections were decidedly keen on their gardens. They could explain the difference between the germination and growth of one plant from those of another where circumstances demanded different treatment and handling; they made up their beds, dug vegetables, etc., etc., as satisfactorily as could be desired. In some cases, two and three sales of the produce of their gardens had been made during the year, and the proceeds used in giving treats by way of encouragement. This stage passed, the proceeds of future sales will be applied to the general working and improvement of the plots with, perhaps, one annual treat. The excellent condition in which most of the plots inspected were found has not been merely an annual inspection show, as, at frequent intervals during the year, specimens of splendidly grown vegetables such as carrots, turnips, sweet potatos, corn, etc., etc., were sent to the Education Department as samples of what the gardens could produce. Besides this, the plots have been watched by means of surprise visits, so as to encourage steady work and to note where only spasmodic efforts may have been made.

It is only within recent date that, owing to the proper constitution of an Agricultural and Commercial Society, definite effort has been directed towards arresting the irregularity that has characterized nearly every attempt to have Agricultural and Industrial Shows as regular annual fixtures; and owing to past irregularity it was not to be expected that the initial efforts of primary school teachers in their gardens would receive that distinct recognition, which alone can make the public appreciate the work that is being studiously and methodically, pursued by them. The newly formed Agricultural and Commercial Society, however, has been good enough to offer prizes for competition for produce exhibited from school gardens at the exhibition to be held in February 1905.

In the schools possessing plots in Grenada, little or no attempt at pot or tub culture of plants has been made. In one instance, a very pronounced attempt at establishing a flower garden adjoining the agricultural plot was in evidence. In St. Vincent things were just the other way about, several schools having been awarded Diplomas of Merit by the Imperial Department of Agriculture for the excellence of their exhibits in pots and tubs at the Agricultural Show held in the month of March 1904. In both places, there is a marked absence of compost heaps; and with one exception only in Grenada, small

experiment corners and nurseries under shelter and with proper protection from insects, etc., have not yet been recognized as being almost indispensable to the successful development of the plots. With improvement in the directions here indicated, and the regular assistance of an Agricultural Instructor at the annual examinations, the permanent value of much that has been taught with an eye to utility would be greatly enhanced.

I am fully satisfied that, as I have had occasion to point out elsewhere, with the foundation of agricultural teaching laid in the upper standards of the primary schools, and the services of an Agricultural Instructor at the annual inspections to put the theory taught to a practical test, the Imperial Department must thereby gradually find itself in close acquaintance with the condition of the large number of peasant proprietors' holdings which are known to be the mainstay of the prosperity of Grenada. These very pupils in the upper standards must, sooner or later, take the places of their parents, and in this way become the medium of communication between the Department at one end and the peasants at the other. The value of forking, draining, and manuring, and the observation and treatment of ordinary plant diseases are the principal heads under which the intelligent application of the teaching at schools, with the assistance of Agricultural Instructors, has, during the past three years, generally manifested itself, and marked a difference between the systematic cultivation carried on by the peasant of to-day, and the casual and unmethodical treatment of new or established cultivation of the past.

As a certain means of promoting success in the agricultural curriculum of schools I have found, both in St. Vincent and Grenada, the inclusion of plant life and kindred subjects in the object-lesson courses in schools very useful. Gradually, and perhaps unconsciously, much of the lack of sympathy for the teaching of this subject, which has in the past been very marked, has been removed; and in both islands I have reason to believe that another period of three years will find the undercurrent of opposition, which was so well known to characterize the first appearance of the teaching of agriculture as a new venture, entirely removed.

With regard to (a) Permanency of tenure or title, (b) Praedial larceny in connexion with school plots, I am pleased to record that in the two islands precaution has been taken to observe and carry out the suggestions of the Commissioner in preventing grounds for complaint under either head, and that, so far as I am aware, there exists no cause whatever for anxiety in relation thereto.

In conclusion, although the number of gardens under cultivation is comparatively small, still, as I have already observed, the work done represents entirely new work; and the keenness of the pupils everywhere who have gardens to cultivate, coupled with the fact that in many instances the teachers themselves cultivate small holdings, gives me the assurance that, at least, a fair start has been made, and that,

with time and the remedying of the defects noted, the school gardens of Grenada and St. Vincent will in the near future compare favourably with those of other colonies.

The PRESIDENT: I am glad the Conference has received Mr. Harbin's paper in so appreciative a manner. He carries on his work under difficulties, and I feel sure that the sympathy he has received will be of great encouragement to him in the future. Mr. Harbin has mentioned that at agricultural shows in St. Vincent prizes were to be offered for exhibits from school gardens. This we are trying to make general throughout the West Indies. Every agricultural show that receives a grant from the Imperial Department of Agriculture is required to have a special class for school exhibits. At Barbados we have started local shows as a means of enlisting the interest and sympathy of people in the out-districts. At Jamaica local shows have created that interest and love of agriculture so graphically referred to by Mr. Williams. At Trinidad special shows have been organized for school exhibits, and the success that has attended them is very gratifying. The Imperial Department of Agriculture has been working steadily for a period of six years, and I believe the general sense of the Conference is that we are making steady and satisfactory progress in all directions. Agricultural education is at the root of the successful development of these colonies. I regard no Conference in the West Indies as complete without careful consideration being devoted to the question of agricultural education.

POPULAR AGRICULTURAL EDUCATION IN JAMAICA.

BY J. R. WILLIAMS, M.A.,

Inspector of Schools, Jamaica.

The efforts made to improve agricultural education in Jamaica during the last few years cover a good deal of ground. The first obvious requirement was a suitable text-book, and in 1891 we succeeded in getting *Tropical Agriculture* from Dr. Nicholls. After a while, also at the instance of our educational authorities, the two *Tropical Readers* were compiled for use in the schools. In 1897, the Principal of Jamaica College made a tour of the Agricultural Colleges in the United States and Canada and reported to us what other people were doing. Side by side with this, we made some attempt in the codes of 1895 to secure practical agricultural work in the schools by offering a special grant for properly cultivated school plots. During the last few years there has been steadily increasing effort to promote agricultural education both in the schools and outside of them, and the Imperial Department of Agriculture has done much to assist us both by means of its officers and by means of its publica-

tions, amongst which I am bound to mention with special gratitude Dr. Watts' *Nature Teaching.*

Now, conspicuous amongst the lessons which lie on the surface of these our efforts in Jamaica are two points:—(1) the importance of preparing the ground by creating interest and sympathy in the work amongst the adult population, and (2) the importance of doing all that can be done to equip the teachers for the new requirements imposed upon them, before we expect practical results. Agricultural teaching, like other teaching, must be judged by its fruits. Although improvement in practical agriculture is only one of the fruits which we properly demand from the schools, it is a very important result.

Our attempt in 1895 to secure practical work in elementary schools was, to all intents and purposes, a failure. The results, agriculturally, tended to bring school agriculture into contempt: educationally there was little to commend. We had made the mistake of expecting seed time and harvest to proceed with equal step. At the best it would have been a plan very slow in result to work principally through the schools, for unless we induce improved cultivation amongst the population immediately productive, we postpone too far into the future that improvement, need for which in Jamaica was imperative and urgent, and constantly becoming more urgent, as the old wasteful cultivation made suitable land scarcer, and as the pressure of outside competition tightened its grasp. Nor did our plan promise sure, if slow, success, for in the absence of outside co-operation the schoolmaster's efforts evoked very little response.

Further, the outside population was at first exceedingly apathetic and indifferent, if not actively hostile. Parents objected to the soiling of the children's clothes in practical work; objected to the teachers making money out of their children's labour; contended that book learning and nothing else was what they had sent the children to school for, and that as a matter of fact they were in a better position themselves to give the practical teaching which the teachers professed. In the last contention there was often sober truth. The consequence was that the schools attempted seriously to earn the special grant, and it was often an amusing as well as a saddening spectacle to view the cultivations 'where but a few torn shrubs the place disclosed' which were the subject of claim for special grants.

It would have been strange if the attitude of the peasantry had been different in this matter, and it was we who miscalculated. Emancipation was only two generations behind. With us, as in the Southern States of America, it was followed by silent but stolid revolt against manual and industrial work, and very insufficient measures had been taken by those who were responsible to break the violence of the transition from forced labour to free citizenship. Tropical climate did not stimulate physical exertion: tropical luxuriance made continuous effort to secure bare subsistence almost superfluous. The discipline of the years of slavery had not tended to organize home life or to

implant ambition towards the attainment of personal comfort. Whatever the changes and chances of life had been, food had been secure and the emancipated peasant could not foresee the day when food might fail. As remuneration diminished, his service became more intermittent: he acquiesced in the oppression of outside circumstances or blamed the governing classes. When the neighbouring planter endeavoured to improve his living by improved machinery or more economical production, it was only the economy effected by reducing the price of labour that caught his observation: he saw no need himself to make two blades of grass grow where one had grown before.

Besides, while the great majority of the peasantry were outside of the range of educational influences, the few who had come under them thought that education meant nothing but book work of a conventional literary type: the schools were the children of the Churches and one of their main objects was to teach people to read the Bible. With the best intentions they foredoomed themselves to failure by dissociating themselves from the home life and home interests of their scholars. The ministers themselves, full of zeal for the bettering of the conditions of life among the people, were mostly men in whom the educational traditions of the Reformation lingered on, or were drawn from the class of social reformers, at one time a large class in England, who firmly believed that increased knowledge was the only leverage needed to elevate the masses. The ministers were the men of superior education with whom the labouring classes had most intimate contact: they were able to live by their education. Small wonder then has it been that we found the general population and teachers alike needing a change of ideal as complete as those classes in America whom General Armstrong at Hampton and Booker Washington at Tuskegee have been trying to convert.

It is not surprising that in the face of this situation there is not as much in the way of practical agriculture in the schools in Jamaica to report as one might wish: perhaps there are hardly 100 schools now with school gardens and very many of those have been lately started. But I believe (and I have excellent opportunity for judging sanely) that there has been very considerable change in the attitude of the general population on the subject. We need perhaps to alter somewhat the conditions under which we offer the special grant for practical work, and a committee is now considering this particular point. We have done what I think is the more difficult work of preparing the ground.

The means by which we have succeeded in getting this encouraging change seem to have been in the main these:—

First, we have gone some way in making school agriculture attractive by improving the teacher's power to teach. No one can teach with enthusiasm what he does not know, and we have learnt that industrial and agricultural teaching power cannot be improvised. In our Training College course, Latin and the higher mathematical work have been struck out; additional importance has been given to the science subjects and particularly elementary agricultural science;

more importance also to the professional subject of school management and the practice of teaching in the practising schools. At the Female Training College at Shortwood an interesting departure has been made in admitting a certain number of the girls, who fail in the competitive entrance examination, to a year's probation for domestic service in the institution (with opportunities for instruction at the same time) until they prove themselves fit for admission as regular students. It is easy to see what excellent results in semi-industrial training in home work are thus afforded to these future female teachers.

Besides, opportunity has been given the last few years to the teachers actually employed in the schools, who had no such opportunities during their training—sixty to eighty of them at a time—to get a few weeks' special agricultural instruction at the Mico Training College in vacation time, when the educational plant is lying idle. Part of this instruction is also practical, and in the evenings they get help in learning drawing and such other manual work as is required of them in the schools. While this does not aim at being exhaustive, it is of great assistance in starting the work on right educational lines, a point of the greatest importance.

In these ways we may reckon that nearly one-half of the principal teachers now at work in our elementary schools have received some special training in the teaching and work of agriculture. The number of schools applying for permission to undertake practical work is rapidly increasing. The number of teachers who apply for places in the special agricultural course is always much larger than can be accommodated; the difficulty is to find instructors for them while the ordinary college staff should have its holiday. I need not tell you that the help afforded us by the Imperial Department in supplying the services of an agricultural lecturer, Mr. Teversham, has been invaluable in this work.

In the second place, the operations of our Agricultural Society must be very largely credited with the improvement in popular agricultural education. Much of its effort inevitably takes the form of preaching, and the preaching of agriculture is subject to the same disappointments as that of higher subjects; the proportion of result to effort is mostly small. We have to be comforted with the reflection that even the small result is needed, and no other way appears of obtaining it. Last year there were forty-one local branches of the society scattered all over the island, with a total membership of 2,568. It has retained the sympathy and co-operation of the employer classes who make up its board of management, and many of them actively assist and guide the local societies in their neighbourhood. The hearty co-operation of the ministers of religion has also been of great help in enlisting the confidence of the people. A nominal subscription of 1*s*. per annum secures membership in a local branch, and although these branches are as independent as they like, they get advice and help of all kinds from the Secretary and the Committee of the central board, which also circulates

information amongst them by means of leaflets on matters which need to be brought before them from time to time. They pay only an annual 5*s.* affiliation fee to the central society, and as their small funds accumulate they buy tools for common use, or seeds or plants for distribution among members, or buy well-bred animals to improve the local small stock, pigs and poultry. One society has provided itself with a stud ass, and several of them have been enterprising and capable enough to carry through successful agricultural shows. It may be that the establishment of the Agricultural Society will prove to be one of the biggest events in Sir Henry Blake's administration. It shows the beginnings of co-operation amongst people whose inability to co-operate and lack of public spirit have been amongst their most discouraging characteristics. The service, social and political, which they render in affording opportunity to representatives of every class in a district, to meet and talk over matters of common interest, and to get to know each other, is exceedingly valuable. Not a little of the improved popular attitude to agriculture is due to these societies.

Besides the establishment of the local branches, several of the other enterprises of the Agricultural Society have been particularly useful.

The 1*s.* annual subscription to the local branch secures to each member a monthly copy of the society's *Journal*, and 3,250 copies per month was its last reported circulation. It contains enough of useful matter to make it interesting to all classes, and amongst the lower class it is playing an important part in education in introducing the use of printed matter as a source of practical interest and information.

The agricultural shows have been similarly serviceable. Eight shows were held last year: four others were arranged for, but were postponed in consequence of the hurricane in August 1903. These are managed economically, for only three shows got a grant of over £20 from the society, and none of over £50, the rest of the money being raised locally; and there are mixed shows with prize lists varying from £50 to £200, and include exhibits of stock of all sorts and riding and driving exhibitions. Their usefulness will be increased when the Instructors can devote their time at the shows to explaining in the sheds to people interested the merits and defects of exhibits, and when we can afford to exhibit *at work* the appliances we encourage people to buy and use. The utmost advantage should be taken of the opportunities shows afford as object-lessons: and object-lessons need explanation.

The Agricultural Instructors whom I have mentioned are partly evidence of the improvement of agricultural education as well as the very useful promoters of it. A few years ago they would have been regarded as the subtle agents of the tax-collectors. We have six of these gentlemen at work, each in an appointed district for several months: and besides practical instruction and visitation they lecture to meetings under the auspices of the local branches; or, where there are none of these, under the auspices of the minister in Church or Chapel. We often now have the encouraging symptom of

impatience when they are transferred out of one district to another and applications for their services long before they are available.

Two years ago, a small experiment was tried by this society which has been very useful for the purposes that are the subject of my paper—the prize-holding scheme. Three parishes at a time, parishes in which agricultural instructors were working at the time, were taken as the area of operation. In each of these, prizes of from £4 to £2 were offered for the best-kept holdings which were entered in separate classes, under 20 acres, under 10 acres, and under 5 acres, respectivelv. The judging, carried out by the Instructor, with any help he might secure, was according to *marks* in which permanent crops, catch crops, buildings and fences and general arrangements were the chief sub-divisions. Sometimes, nearly as many as 100 entries have been made in a single parish. As each competitor becomes a centre of subsequent ambition in his neighbourhood, people will, we hope, pay increased attention to the holdings on which they live, and aim by better and more permanent cultivation to keep their crops at home under supervision instead of offering facilities to the praedial thief by working in remote and isolated spots. As they appreciate the meaning of home comfort they may be expected to labour more sedulously to obtain it.

Such a statement as I have attempted of what we have tried and the results of our efforts might reasonably be followed by an attempt to indicate the direction in which we should lay all our weight in the future. But this paper is already longer than I intended and lists of wants are apt to be long lists, and the condition of our public purse counsels moderation. Two points, however, seem to me of such importance that I beg you to bear with me if I merely mention them. One is the need for a local institution of a collegiate character where scientific agriculture in all its branches can be practised and taught for the benefit of those who in the future are to be the employers of labour, and the owners or managers of estates. Education does not usually rise up, it filters down, and the most successful means of improving popular agricultural education is undoubtedly the object-lesson of properly organized work under efficient management. The other point is this: to develop agriculture as part of our work in elementary schools we need to keep it educational, as a part of the instruction that will react upon and vitalize the whole, not as a separate subject to be specialized. To secure this, it is needful that the practical agriculture be always under the control of, and be *tested* by, those who control, guide, and value the other educational work of the school. I see the chance of much confusion, of practical agricultural teaching being perverted to improper ends, if, as has been sometimes proposed, the practical work be delegated to purely agricultural officers. It is indeed desirable that these should teach and advise and inspire, but it is the educational value of agriculture, moral, manual, and intellectual, that is to measure *out* judgement as to its success in school work.

Conditions vary to such an astonishing degree in the different colonies which are represented here, that I shall not be surprised if to many of those present who have a different outlook at home, much of what I have said appears irrelevant and unreal. Nor is it contended that in Jamaica there is anything like a complete revolution in popular feeling. I merely see an augury of better things, which it is impossible to substantiate with facts and figures, because, in the nature of the case, such are impossible. But standing at the back of almost every problem we have discussed at this Conference is the difficulty of labour. We have it in Jamaica, as elsewhere, but in a different form from Trinidad and British Guiana: with us the difficulty is to make active and efficient and available, the labour of a population of nearly 800,000 of mostly very poor people, which for various reasons is not available in the way that it is wanted, nor efficient, nor as profitable as it should be either to the labourer or the community.

In improved popular education we may hope to find one of the avenues leading to the solution of our problem. There is so much that is ethical and economic to make it a very complex problem that we must be thankful if, with the help that the Imperial Department of Agriculture has given us, we may venture to hope that we have gone a little way along the right road.

DISCUSSION.

Mr. J. H. COLLENS (Trinidad): Two or three years ago it was stated by one of the Jamaica representatives that the people of Jamaica were at that time showing considerable antipathy to agricultural work in elementary schools. I should like to know from Mr. Williams whether that feeling is disappearing, and whether the children and their parents take to the work more cheerfully.

Mr. WILLIAMS: There is considerable improvement in the attempts to teach agriculture in the schools, as well as in the impression of agricultural education in general throughout the island.

AGRICULTURAL INSTRUCTORS.

The PRESIDENT: Arising from this there is one matter that has not been touched upon, and that is the work done by the travelling Agricultural Instructors. We are not aiming at educating only those in schools or in charge of schools, but all cultivators of land. I would invite brief statements to be placed before the Conference by those who are most closely associated with this work. Agricultural Instructors were started years ago in Jamaica, and I believe efforts have been more successful there than in any other part of the West Indies. Jamaica has six Agricultural Instructors at work, and any one who reads the *Journal of the Jamaica Agricultural Society* will observe what excellent work these men are doing and the useful results they present for publication in that journal.

The Hon. WILLIAM FAWCETT (Jamaica): Mr. Williams has already given the Conference some information about the work of Agricultural Instructors, but perhaps I may add a few words. At the first Conference held in Barbados, I had the honour of reading a paper describing the efforts made in Jamaica to start this work. We had very great difficulty at the beginning in getting the upper classes to take the slightest interest in it, because they supposed it would not do any good, and the apathy shown by the schools did not encourage matters. Interest, however, was subsequently aroused, and soon the demand for instruction by the people was so great that now we have six Instructors, two appointed by the Board of Agriculture, and four by the Agricultural Society. But we could find work for double or treble that number, if we had the money. As the result of their work, in certain districts, land, which had been abandoned for a long number of years and was said to be barren, is now being well cultivated by the people in yams, coffee, and other provision crops; also land hitherto under bush is being cleared up and forked, and mulched with the weeds and bush that are cut down. Then again, the Instructors showed them the use of improved tools. Instead of curing their coffee or cacao on the bare ground, they show them what better results they will get if they use a coffee pulper with their coffee or a box with their cacao: and we find the people buying a coffee pulper and lending it to their neighbours, or making a charge for pulping. So also with regard to corn shellers and their sugar mills. Three or four of them would join together and purchase tools and implements: they also co-operate in the sale of their produce, sending it to England or America. To show how valuable the work of the Instructors is, and how greatly it is appreciated by the people, I may mention that those districts, in which there are not any Instructors at present, are clamouring for the advantage that is being given to other districts. The great difficulty is the want of money; but we hope we shall be able gradually to extend the benefits of Instructors to the whole island. I am sure there is no better way of improving the cultivation by the people than by Agricultural Instructors.

The Rev. Dr. MORTON (Trinidad): In Trinidad we have two Instructors. They have to submit to a certain amount of adverse criticism. I have never criticized them: I advise them. But notwithstanding the criticism, they are doing excellent work throughout the country. Opportunities are given them in our schools of showing what they are doing, and I must say I was extremely pleased with the last lectures and illustrations given us. I had pleasure then, in the face of adverse criticism which came from certain quarters, to say that I thought the Instructors were doing good work which fills a gap that none of the other agencies can reach.

The Hon. B. HOWELL JONES (British Guiana): In British Guiana we have three Agricultural Instructors, namely, Mr. Ward, Mr. Beckett, and Mr. Mansfield. They go about visiting the various districts, and instructing the owners and managers, and inspecting the school gardens, and looking after the practical work. A great impetus has been given to cultiva-

tion and the Instructors are sought after more and more by people in the villages.

Mr. G. S. HUDSON (St. Lucia): In St. Lucia we have been using Blackie's *Tropical Readers* now for five years, and the examinations are conducted on that text-book. We have had two courses of lectures, which were attended by about thirty-five school teachers. There are forty-two schools in the island and thirty-two school gardens; the conditions of the schools without gardens are such that it is impossible to have gardens attached to them. There is also a dairy. The school gardens are visited by the Agricultural Instructor when necessary and when requested. There are twenty boys at the Union School, and some of them are commencing to leave the school and accept employment on the estates as overseers. I know of three cases in which the boys have been so employed and have given satisfaction. The principal part of my own work is visiting planters and overseers. When I first took it up, I met with a little opposition; but that attitude has now entirely disappeared and I am frequently called on to advise planters, and I find my advice very frequently followed. I think even more good is done by the experiment plots, not only in cacao, but cotton, limes, pine-apples, etc. I find that where we can show the actual results to planters, they take a great deal more notice and are more likely to follow our advice than any amount of talking and persuasion would influence them to do. Another matter which has caused the work of the Instructor to be appreciated is the small cost at which the experiment plots are worked: we cultivate an acre at a cost of £5 to £7 a year. We have also done a good deal of good by the distribution of artificial manures in small quantities under my supervision.

The PRESIDENT: Is any attention being devoted to the preparation of pen and compost manures?

Mr. HUDSON: That has not been neglected. We have formed local branches of the Agricultural Society in the most important agricultural districts: and a feature of these is that there is no subscription. We hold monthly meetings and try to get the principal people to attend: the idea is to get hold of the peasant, not the man who is better educated. We have also assisted in importing animals—bulls and pigs—with the view of improving local varieties, and we are getting good results from these. Bee keeping is also taken up, and several tons of honey have been shipped this year. These are a few of the matters that occupy me in St. Lucia, but there are hundreds of points which crop up in the course of the year on which I am able to afford information to the Government, the Agricultural Society, or the planters.

Dr. FRANCIS WATTS (Leeward Islands): I should like to point out, lest there should be any misapprehension, that in the smaller islands the Curators very largely play the part of Agricultural Instructors. That is so particularly in the Virgin Islands. In Antigua, St. Kitt's, Nevis, and Montserrat, during the recent efforts to produce crops of cotton, the Curators, Mr. Patterson in Antigua, Mr. Shepherd in St. Kitt's,

Mr. Hollings in Nevis, and Mr. Jordan in Montserrat, have visited almost every plot of cotton grown. An immense amount of work is done by these Curators, which would be done in other colonies by the Agricultural Instructors, and I am anxious that the efforts of these officers should not be overlooked. While speaking on this subject of agricultural education, perhaps I may be allowed to express my great surprise and pleasure at the different tone which has prevailed generally at this Conference, in this matter of agricultural education. When we first began to discuss this subject at previous Conferences, everybody shrugged his shoulders and asked: What can we do? To-day everyone can point out that substantial progress has been made during the last few years. That is a most remarkable development, and a development of great importance, because it has proceeded along the line of individual interest in the work; if this interest can be diffused through all classes, from the highest to the lowest, we may rest assured that the increasing educated population will work out for itself increasing progress on the lines we try to indicate and ensure by these Conferences. We may therefore congratulate ourselves on the great change in the tone of the discussions on this question which has been shown to-day.

Mr. J. H. HART (Trinidad): The work of the Agricultural Instructors at Trinidad is carried out in the following manner: The two Instructors, who were appointed in 1902, meet and prepare a programme of work in the middle of each month for the next ensuing. This programme is viséd and approved, or corrected if necessary; and the work is directed from time to time in the intervals of their journeys by the Superintendent. A report is furnished by each Instructor at the end of every month, and entered in the Report Ledger, a copy being forwarded for the information of the Government. The work of the Instructors has been freely criticized, but their services are greatly in demand and much appreciated. Two demands have been received for resident Instructors in addition to the two already employed. The Superintendent undertakes lectures in the principal centres at intervals, with demonstrations. These have been well attended and popular. The lectures at the training schools for teachers are a special feature. The Instructors visit, direct, and report upon the experiment plots which have been started during past years. These will be reported on in due course, but the operations are not yet ripe for report. The work, on the whole, is progressing satisfactorily. The value of the instruction given has been plainly seen in the produce exhibited at schools and other shows. Great improvement in quality has taken place.

The Hon. B. HOWELL JONES: I should like to add that there are out-lying districts in British Guiana, one of which is visited once every year by Mr. Ward and Mr. Beckett, who remain there a fortnight, sometimes longer, and give practical lessons to every one who desires information. These districts produce fine crops of cacao and coffee, plantains and various ground provisions. With regard to instruction to planters, I may mention that at the Laboratory in Georgetown, Professor Harrison gives a course in chemistry in connexion with the

manufacture of sugar, or lessons in general chemistry, at a moderate scale of fees, to every one who applies for it, so that any young man engaged in agriculture may go there and obtain instruction in his work.

The PRESIDENT: While engaged in this work with the peasantry we do not neglect the planters, and it is one of the duties of the Agricultural Instructors, as indeed of all officers of the Department, to attend meetings of the Agricultural Societies and give advice and assistance at the meetings of such societies, with the view of improving the agriculture of the colony in which they reside. In this connexion I may mention that very valuable work is done by Dr. Watts in Antigua. The society there follows him very closely in all his work, and there is no one more valued than he is. We desire that same kind of work gradually to spread all over the West Indies, so that planters in their societies may always have the best scientific knowledge at their disposal in aid of local industries. I mention this in order to show that the work of the Department is not confined to any particular class of agriculturists but is available to all members of the community.

ARBOR DAY IN THE WEST INDIES.

The PRESIDENT: As a part of our agricultural education scheme I should like to bring before the Conference the observation of Arbor Days. The question has been taken up with a considerable amount of enthusiasm in some parts of the West Indies; in others there has been partial, if not entire, neglect. It would be useful if to-day we could lay down some general lines as regards what an Arbor Day is intended to serve. I may mention at once it is not the intention to plant trees with a view to re-afforestation. That view is sometimes taken, and in one colony the Agricultural Society took the extreme course of discouraging the observation of an Arbor Day, because they said: 'There are quite enough trees in the island already and we do not want any more.' That may be a good argument from the point of view of re-afforestation, but not from the view of an Arbor Day as we desire it. What we hope to accomplish by Arbor Days is this: to have a few special trees planted on certain days in order not merely that children may develop the desire to perpetuate an event by the planting of a tree (handed down to us from the earliest times), but that they should always have before them the operations necessary to prepare the ground and look after the tree until it is thoroughly established. That, from an educational point of view, would be a valuable acquisition for the individual as well as for the community. I can understand that some people may think that an Arbor Day is not necessary in a locality where vegetation is very abundant; but the idea is to plant a specimen tree only in a suitable spot, such as an enclosure, school garden, or lawn, and keep such tree continually under

observation in order to illustrate the methods and conditions best adapted for tree life. I would now invite observations from members of this Conference as to their experience with regard to Arbor Days.

The Hon. WILLIAM FAWCETT (Jamaica): The last Arbor Day in Jamaica was held on May 24. Over 600 trees were distributed by the Botanical Department, and instructions were issued that the trees were not to be planted for the purpose merely as trees, but as examples of what care and attention were necessary in the cultivation of trees, so that teachers and others could lead their students to observe the beauties of nature and give lessons while the trees are growing. We have taken care to insist upon the individual value of every tree planted on this particular day. I do not know how far our instructions have been carried out, but we hope the people will be led to recognize the value of Arbor Days by these means.

Dr. FRANCIS WATTS (Leeward Islands): Arbor Days have been celebrated in the Leeward Islands for several years past. In Antigua where the movement was taken up with a great deal of vigour, we have had three successive Arbor Days. These have been days held to commemorate the King's birthday. It seems a fitting thing to combine Arbor Day with the King's birthday. The first Arbor Day was arranged to take place at one central point only, namely, St. John's, where the school children assembled in the early morning in the public park to plant trees. Then, in order that the movement might be one of general interest, we invited the Governor and leading members of the community such as the Chief Justice, and members of the Executive Council to plant trees in order to improve the approach to the town from the Victoria Park. The school children planted an avenue of mahogany trees in the park, and the scholars of other educational establishments planted clumps of trees. As showing the interest taken by the children and the people generally, I may mention that it is customary in Antigua, on the King's birthday, to have a display of fireworks and bonfires; the display took place where the trees were planted, and no destruction was done to the trees or the guards. One tree was uprooted, probably by a inquisitive child. The general result was, I consider, highly creditable, when we remember that the crowd consisted of some thousands of, more or less, excited and hilarious persons. The following year, in addition to observing Arbor Day in St. John's, celebrations were arranged in various parts of the country. On that occasion the planting of an avenue of mahogany trees along one of the main roads leading into St. John's, by many of the principal ladies of the community, headed by Lady Edline Strickland, was made one of the chief features, while the schools continued their work of the previous year. On the third, and most recent occasion, Sir Courtenay Knollys, Lady Knollys, Miss Knollys, and Mr. H. L. Knollys planted trees in a space near to the entrance to Government House. Another principal feature of this day's celebration was the planting of trees by thirty-two young ladies. The pupils of the Grammar School and the

Girls' High School planted palms in selected places in the streets of St. John's. In addition to this, trees were again planted by the elementary school children. In the country, celebrations proceeded on similar lines. the children of the schools taking part. Interest in the work is extending, and in addition to the public celebrations, many persons plant ornamental trees and fruit trees. In St. Kitt's an attempt was made some time ago to observe Arbor Day by the planting of a solitary tree which did not thrive. Last year an Arbor Day was arranged by Mr. Shepherd, and most successfully carried out at the Botanic Station, the Administrator and many leading gentlemen taking prominent parts. A similar thing was done in Nevis, where a successful attempt was made to beautify a newly made Cemetery. Thus interest in the movement is spread; the idea kept prominently forward being to teach the people to care for trees, to observe and recognize their influence, their mere numerical increase being regarded as quite secondary.

Dr. H. A. A. Nicholls (Dominica): If not already known, it will soon be known that the Dominica Agricultural Society is the society to which the President refers as having taken a different view on the subject of Arbor Day observation. The circumstances connected with the society's decision are as follows: The Chief Executive Officer for the time being, addressed a letter to the Agricultural Society stating that it was proposed to institute an Arbor Day, and asking one of the officers of the society to take a seat on the Committee about to be appointed to carry out arrangements for making the celebration. In reply to that communication the attention of the Executive Officer was called to the fact that the conditions of Dominica were different from those of the other islands forming the colony of the Leeward Islands; that any one planting a tree in those islands might be regarded as a public benefactor as there were far too few trees in them; but that in Dominica the case was quite different, and local conditions had to be considered. It was the intention that Arbor Day should be observed only in Roseau, but it was considered by medical men that there are far too many trees already in Roseau, and from a sanitary or medical point of view it would not be a good thing to plant more trees there. There are other parts of the island where trees could advantageously be planted; but the Agricultural Society was not approached with the idea of giving advice or assisting in the formation of arrangements, but was asked to allow one of its members to sit on the Committee out of mere compliment; that being so, the society said that it did not see its way to take any part in the movement.

The President: I have been glad to afford Dr. Nicholls an opportunity to make his explanation; but I may add that even at Roseau in the extensive Botanic Gardens and the open piece of waste land to the south of the town where the trees were actually planted on Arbor Day, a few really attractive trees would be likely to add to the amenities of Roseau without injuriously affecting its sanitary condition.

APPENDIX.

The following extracts from the *Agricultural News* are reproduced here with the view of indicating what has already been done in the West Indies in connexion with the Arbor Day movement:—

As far as we are aware, an Arbor Day movement has not yet taken firm root in the West Indies. The subject which is discussed elsewhere in these pages has, on several occasions, been suggested in the press, and spasmodic efforts have been made by a few. We recur to it because we believe that the proclamation of an Arbor Day and the systematic planting of ornamental and shade trees under suitable auspices would greatly tend to advance the social and public interests of these colonies.

The movement would be beneficial in many ways. It would instil into the minds of the rising generation the almost sacred duty of trying to leave the world a little better than they find it; it would familiarize them with the needs and requirements of plant life, and infuse a spirit of regard and affection for trees and check the almost universal desire, now existing, to cut down and destroy, rather than cherish, what might become useful and ornamental. In this matter of cutting down and destroying trees it has been remarked that many people 'hold the cent so close to their eye as to obscure the dollar beyond.'

The systematic care and attention to detail called forth by the planting and nurture of even one tree and watching its growth and development could not fail to have a formative effect on character. It would, further, have a high educative value in cultivating the love of Nature and the observation and interpretation of her wonderful laws.

There are also to be considered the advantages to the general community arising from the beneficial influences of trees in affording delightful shade, in softening the torrid heat of the sun, in providing fuel, and in bringing forth abundant fruit for man's enjoyment.

The subject is not new. It may, nevertheless, require mention many times repeated. The quaint, but fervid, appeal of Gerharde, in 1633, is as applicable to-day as it was 269 years ago:—

Forward in the name of God! graffe, set, plant and nourish up trees in every corner of your grounds; the labour is small, the cost is nothing, the commoditie is great, yourselves shall have plenty, the poore shall have somewhat in time of want to relieve their necessitie, and God shall reward your good minds and diligence. (*A.N.*, Vol. I, p. 40.)

ARBOR DAY AT ST. VINCENT, TOBAGO, AND JAMAICA.

Notwithstanding the postponement of the Coronation ceremony, June 26, 1902, was observed in St. Vincent and Tobago as an Arbor Day. At St. Vincent, Mr. Henry Powell, the Curator of the Botanic Station, reports that tree planting was duly carried out at Government House, the Botanic Station,

and Agricultural School, and similar commemorative trees were planted in the market places at Kingstown, Calliaqua, and Barrouallie, and at the residences of several private individuals. Altogether, fifty-nine trees were planted at St. Vincent. More trees, Mr. Powell states, would have been planted, had not the general conditions of the island been upset by the recent volcanic disturbances.

At Tobago a bed was prepared in the centre of the Botanic Station and planted on that day with a group of cabbage palms and ornamental shrubs. A cabbage palm was also planted at Government House and another at Fort Hill. At the latter place, the function took place in the presence of the Warden, the Curator. and a large gathering of school children. To the latter was explained the object of the ceremony. Altogether twenty-one trees were planted at Tobago.

At Barbados, also, a few commemorative trees were planted; but the majority of the trees have, we understand, been retained to be planted on the actual Coronation Day. In supporting the idea of establishing an Arbor Day for the West Indies, Mr. Fawcett, the Director of the Botanical Department, suggests that at Jamaica, Victoria Day (May 24), being a recognized public holiday, might be a convenient day for the purpose. Mr. Fawcett adds: 'There are numerous occasions which would be fittingly marked by the planting of trees, such as children's birthdays, the visits of friends, the anniversaries of national or local important events. But no one should undertake to plant a tree unless it is fully intended to take care of it afterwards, otherwise it will remain a monument of careless indifference. A list of available plants at the Jamaica Gardens is published in the *Gazette*. But if there is likely to be a universally observed Arbor Day, it would be well to give notice some months beforehand of the plants required. The Government is willing to help all interested in the movement.' (*A. N.*, Vol. I, p. 101.)

TRINIDAD, GRENADA, AND TOBAGO.

It is gratifying to find that active steps have been taken to give practical effect to the suggestion made in the *Agricultural News* of establishing an Arbor Day in the West Indies.

At Trinidad Mr. J. H. Hart reports that a tree was planted on Coronation Day (August 9, 1902) in the Queen's Park Savannah by his Excellency the Acting Governor, Sir C. C. Knollys, K.C.M.G. Mr. Hart continues: 'It is to be hoped that this excellent example will be followed in each subsequent year by the people in general. The time of year is especially suitable for planting purposes in Trinidad, and it would be a great encouragement to cultivators were a regular day set apart each year for the purpose of planting trees. It is a practice which would tend largely to the benefit of the community, and in which the poor as well as the rich may share, and the ninth of August each year might well be commemorated by the planting of fruit, timber, or ornamental trees.'

At Grenada his Excellency the Governor planted a Genip tree in the Anglican Churchyard, immediately after the Coronation Service, in the presence of a large number of the officials and other residents of the island. Mr. Broadway, the Curator, reports that in all eighty-five trees were planted, some on July 2, the remainder on August 9. In addition to the Genip, trees were planted at the Botanic Station, Government House, the Ballast Ground, the Presbyterian Church, the Bower, St. George's, the Wesleyan Church, the Convent, the Market Square, St. George's, etc.

At Tobago, also, several trees were planted on June 26, and several further Coronation trees on August 9. (*A. N.*, Vol. I, p. 151.)

ANTIGUA.

Arbor Day was celebrated in Antigua most successfully on November 9, 1904, not only in St. John's, but in all the parishes in the island.

The programme for St. John's was as follows :—

(1) The planting of a group of palms by his Excellency the Governor, Lady Knollys, Miss Knollys, and Mr. H. L. Knollys opposite the east entrance to Government House.

Before planting the trees his Excellency gave a brief address.

(2) The planting of thirty-two mahogany trees on the north and east sides of the Cricket Ground, by young ladies.

(3) Planting of twenty mahogany trees, to double the avenue along part of the road through the Victoria Park, by children of the Moravian and Wesleyan schools.

(4) The planting of mahogany trees round the new Anglican school, by the school children.

(5) The planting of avenues of mahogany and palm trees in the grounds of Buxton Grove by the students of the Training College and pupils of the school.

(6) The planting of rows of palm trees in Redcliffe Street and Tanner Street by the pupils of the Girls' High School.

(7) The planting of rows of palm trees in Redcliffe Street and St. Mary's Street by boys of the Grammar School.

Considerable public interest was taken in the ceremonies which now appear to have become recognized institutions.

DOMINICA.

Arbor Day was successfully celebrated in Dominica on the King's birthday. Owing to the existence of such a large number of trees in the island, it was decided that only ornamental trees and palms should be planted.

The movement was purely of an educational character, the object being to foster a love for plants among the children. For this purpose the boys and girls of the Roseau School met at the schoolroom and songs and speeches suitable to the occasion were given, after which the children marched to the

Savannah where the planting of palms was to take place. Twenty-two palms were planted. The planting having been completed, the proceedings terminated with the singing of the National Anthem.

The boys of the Agricultural School took part in the movement by planting a row of ornamental trees along the edge of the Morne, the trees used being *Cassia Fistula* and the Flamboyant, which in time to come should give a beautifying effect to the town. The Arbor Day movement is also to be celebrated by all the schools in the country districts, but as November 9 proved to be inconvenient, the Queen's birthday is to be recognized as a day set aside for tree planting in these districts.

Each tree planted is protected by guards consisting of three square posts around which is fastened wire netting to prevent fowls and cattle from causing damage. The plants used were raised at the station, and every assistance was rendered by the local officers of the Department. (*A. N.*, Vol. III, p. 390.)

Arbor Day was celebrated in the country districts on December 1. Every school in the island took part in the movement. The planters in each district co-operated with the schools on this occasion.

In some cases the planters provided the plants for their own district. This was the case at Belvidere where Mr. P. Cox supplied plants of *Castilloa elastica* for planting along the public road.

The following plants were used on this occasion and distributed by the Botanic Station :—

Castilloa elastica and *Funtumia elastica*, mahogany (*Swietenia Mahagoni*), *Eucalyptus punctata*, saman (*Pithecolobium Saman*), locust (*Hymenaea Courbaril*), *Cassia Fistula*, *Cassia siamea*, almonds (*Terminalia Catappa*), and palms (*Areca Catechu*). (*A. N.*, Vol. III, p. 403.)

ST. KITT'S.

Arbor Day was celebrated in this island on the King's birthday, November 9, 1904. The day was celebrated in this island and over in Nevis with some enthusiasm. The Botanic Station wore quite a festive appearance under the decoration of flags tastefully arranged along the central walk, and a large number of trees were planted within its grounds. The ceremony was formally opened by the Administrator, who addressed an assemblage of over a thousand persons including the children of the various schools in town. He pointed out the objects for which they were invited to meet together, and expressed the hope that not only should trees be regarded by all present as the natural ornament of the land in which they live, but that each should cultivate a love for them and protect rather than injure or destroy them as has been a common practice.

At the conclusion of his remarks three cheers for His Majesty King Edward VII were raised and the planting operations were then carried out, commencing with the

Administrator and followed by members of the Executive and Legislative Councils, members of the Bassetere Town Board, members of the Mutual Improvement Society. and six pupils each from the Grammar School, Catholic, Anglican, Wesleyan and Moravian Schools.

After the ceremony at the Botanic Station a large part of the assemblage repaired to the grounds of the Wesleyan School where upwards of thirty trees were planted.

NEVIS.

Arbor Day was celebrated at Nevis with great èclat. From 700 to 800 school children mustered on the Savannah from all quarters at 1.30. Arrived at the rendezvous, the children were permitted to rest for a short time and then refreshments were distributed. At 3 p.m. the children fell in, and, with bands playing, set out for the new Cemetery which has recently been enclosed by the Government and which had been selected for the site of the tree planting. The National Anthem was sung, and at its conclusion each appointed child decorously proceeded to plant the tree assigned to it. The Inspection Committee passed from tree to tree to ascertain if the planting had been properly carried out.

VIRGIN ISLANDS.

Arbor Day was observed in Tortola, Virgin Islands, on November 9, the King's birthday. The children of the Anglican School assembled at 10 o'clock, and after short explanatory addresses by the Rev. H. L. Monckton and the Agricultural Instructor, proceeded to the residence of the Commissioner, where sweet orange, date, and rubber trees were planted. They also planted saman trees in the market place.

The Wesleyan scholars assembled later, and marched to the Commissioner's residence, where they sang the National Anthem, and planted mammy, sapodilla, and pear trees. Later they planted galba trees on the roadside near the station. Bonfires were lighted at Kingston in the evening. (*A. N.*, Vol. III, p. 390.)

MONTSERRAT.

Owing to local circumstances, it was found advisable to celebrate Arbor Day on different dates in the different districts. In Plymouth, November 7 was observed, and the children from the three schools assembled at the Court House at 10 a.m., and after addresses by his Honour the Commissioner and the Inspector of Schools on the objects of the observance of Arbor Day, they marched to the Windward Road leading from the town, and there planted young trees of locust and *Acacia arabica*. They then marched to 'The Hill' and planted mangos, seeded bread-fruits (*Artocarpus incisa*, var. *seminifera*), and avocado pears.

On November 18, trees were planted at Harris' Village by the children of St. George's School. Addresses were given by his Honour the Commissioner and the Inspector of Schools, and the trees were planted on a plot of land used as a playground

for the school. The trees planted were Casuarina, mahogany, locust, *Acacia arabica*, and Spanish oak. A label, with the names of the children who planted it and the date of planting, is being placed by the Manager of the school, before each tree to retain the interest of the children.

On November 21, Arbor Day was celebrated at Kinsale and St. Patrick's. The children from Kinsale School marched to Fairfield Road and planted locust, *Acacia arabica*, Casuarina, and galba. At St. Patrick's the trees were planted on a piece of land adjoining the school. Addresses were given as on previous occasions. The trees used were date palms, mahogany, locust, *Gliricidia maculata*, Lagos silk rubber, Sesbania, *Acacia arabica*, and Casuarina. The Curator and staff of the Agricultural Department assisted in each district.

Trees were also planted at Cavalla Hill and Bethel Schools, and also by several of the adult inhabitants upon their own land. Altogether 220 trees were distributed from Grove Station for the purpose of Arbor Day celebration. (*A. N.*, Vol. III, p. 403.)

ARBOR DAY.

In view of the fact that preparations are likely to be made shortly for celebrating Arbor Day in the West Indies, it may be useful to discuss briefly some points in connexion with this movement.

The King's birthday (November 9) has been more or less generally adopted as the day for observing Arbor Day in the West Indies. At Jamaica and elsewhere Victoria Day has been tentatively adopted for the purpose. Last year Arbor Day was celebrated with conspicuous success on the King's birthday in Antigua, Dominica, Montserrat, Nevis, and St. Kitt's. It would appear that that date is an appropriate one to be chosen for this purpose on account of its being a Public Holiday for the observation of the birthday of His Majesty the King, who has always evinced so lively an interest in tree planting, while, at the same time, it is usually a seasonable one for planting operations. In most of these islands showers are expected in November and the trees planted at that time would, in most cases, have at least a couple of months, and possibly more, in which to make a start before the setting in of the dry season.

It is recommended that those islands which have not as yet formally set apart an Arbor Day should join in the movement, and that the King's birthday be generally adopted as the occasion for the systematic planting of trees.

It is probably well known to readers of the *Agricultura News* that the local officers of the Imperial Department of Agriculture have given very material assistance in connexion with Arbor Day celebrations. The direction in which this assistance has been most appreciated has been in raising and supplying plants. In almost all cases the young trees planted have been raised at the Botanic Stations. Assistance has also been given in regard to the selection and the preparation of the land and in caring for the young trees afterwards.

It is desirable that committees should be appointed as soon as possible, so that the detailed arrangements for the celebrations may be well in hand. This will enable the officers in charge of Botanic Stations to ensure an adequate supply of suitable plants. At the same time proper sites for planting will have to be chosen. This must be done with due regard to the character of the trees which it is decided to plant. The trees most commonly chosen for this purpose are palms (principally the cabbage palm and the royal palm, *Oreodoxa oleracea* and *O. regia*), mahogany, white-wood (*Bucida Buceras*), and, in one instance that has been reported in the *Agricultural News*, viz., in Dominica, *Castilloa elastica* for planting along the side of the public road. There is a wide choice of suitable trees in the West Indies both for ornamental and shade purposes. There are also several very desirable fruit trees for gardens and orchards.

In order to give the young plants every possible opportunity of making rapid growth, and of fulfilling the purpose for which they are planted in the shortest possible time, special attention should be given to the preparation of the soil. This should be commenced, if possible, early in October. Holes at least 3 feet square and 2½ feet deep, should be dug; these, after a few weeks' exposure to climatic influences, should be carefully filled with good *top* soil. Where, however, the soil is poor or of a rocky nature, a plentiful supply of well-rotted stable or pen manure should be mixed with the soil.

After the young trees have been planted, some protection must be afforded against cattle, goats, and fowls. This will best be secured by the erection of tree guards, which may conveniently be made of three strong posts around which wire netting is fastened, or the staves of a barrel may be used for the purpose. Arrangements should also be made for watering the plants, if necessary, and for subsequent weeding and general attention to their requirements.

With regard to the objects of Arbor Days, it should be clearly understood that in urging its observance the Imperial Department of Agriculture has in view mainly its educational influences. There is no intention to connect it with schemes of re-afforestation. . . .

While, however, the main idea is to be educational, the movement may serve a utilitarian purpose in beautifying the appearance of roads or open spaces, and in affording delightful shade from the torrid heat of the sun. Thus in Barbados, where Arbor Day has not, so far, been observed, it has been suggested that, in addition to affording object-lessons to children in the proper treatment of trees, Arbor Day celebration might be taken advantage of to transform some, at least, of the white, glaring roads into shady avenues, thus adding to the general comfort and well-being of the community.

The great advantage in regard to the observance of an Arbor Day is that a small expenditure, only, is necessary, in a tropical climate, to produce pleasurable and lasting results. (*A. N.*, Vol. IV, pp. 225-6.)

MANURIAL EXPERIMENTS WITH COTTON IN THE LEEWARD ISLANDS.

BY THE HON. FRANCIS WATTS, C.M.G., D.Sc., F.I.C., F.C.S.

The plan upon which these experiments were carried out was published in the *Agricultural News* (Vol. III, p. 237) and was as follows :--

The Department of Agriculture will provide the artificial manures for the experiments, and will supervise their application.

The planter co-operating will be required to prepare the land for the experiments and to plant the necessary dividing lines of pigeon peas: to weed and care for the crop during growth, taking all reasonable precautions for the prevention of insect and other pests, including the provision and application of proper insecticides; to gather the cotton from each plot separately, which can be readily done by having as many bags for storing cotton as there are plots in the series of experiments.

When the reaping is completed, the proceeds of each plot will be weighed, and ginned, and small samples of lint from each plot sent to the Government Laboratory for examination and valuation.

The necessary information concerning the weight of seed-cotton, of lint obtained per plot, and of the general nature and growth of the crop will be forwarded to the Government Laboratory for the purpose of preparing the proper report upon the experiments, in a manner similar to that followed in the case of experiments with sugar-canes. It is desirable that care be taken to provide for concise publication of results; fragmentary and piece-meal publication is to be deprecated.

It is proposed that the experiments shall be arranged somewhat on the same lines as those conducted with sugar-canes, and a list of some thirty-five to forty experiments has been drawn up. These experiments are designed to ascertain the requirements of the cotton plant as regards (1) nitrogen, (2) phosphates, (3) potash, (4) salt, and (5) the influence of sulphate of copper. Other experiments, as for example, those with insecticides or fungicides, may be added to the series, if local circumstances demand the addition.

Each plot is to be $\frac{1}{40}$ acre, and the plots are to be separated from one another by rows of pigeon peas. Arranged in this manner, each series of experiments will require about 1½ acres.

Little difficulty should be experienced in picking the cotton separately from each plot, if a bag is provided for each plot and plainly marked with the number of the plot. The bags should not be carried about from plot to plot while picking is going on.

The following list of experiments has been put forward as suitable for this year's work:—

1. No manure.
2. Pen manure.

NITROGEN SERIES.

3. No nitrogen, 30 lb. potash, 40 lb. phosphate.
4. 20 lb. nitrogen as sulphate of ammonia, 30 lb. potash, 40 lb. phosphate.
5. 30 lb. nitrogen as sulphate of ammonia, 30 lb. potash, 40 lb. phosphate.
6. 20 lb. nitrogen as nitrate of soda, 30 lb. potash, 40 lb. phosphate.
7. 30 lb. nitrogen as nitrate of soda, 30 lb. potash, 40 lb. phosphate.
8. 30 lb. nitrogen as sulphate of ammonia, 30 lb. potash, no phosphate.
9. 20 lb. nitrogen as sulphate of ammonia, no potash, no phosphate.
10. 30 lb. nitrogen as sulphate of ammonia, no potash, no phosphate.
11. 20 lb. nitrogen as nitrate of soda, no potash, no phosphate.
12. 30 lb. nitrogen as nitrate of soda, no potash, no phosphate.

PHOSPHATE SERIES.

13. No phosphate, 30 lb. nitrogen, 30 lb. potash.
14. 40 lb. phosphoric acid as basic phosphate, 30 lb. nitrogen, 30 lb. potash.
15. 60 lb. phosphoric acid as basic phosphate, 30 lb. nitrogen 30 lb. potash.
16. 80 lb. phosphoric acid as basic phosphate, 30 lb. nitrogen 30 lb. potash.
17. 40 lb. phosphoric acid as basic phosphate, no nitrogen no potash.

18. 40 ℔. phosphoric acid as superphosphate, 30 ℔. nitrogen, 30 ℔. potash.
19. 60 ℔. phosphoric acid as superphosphate, 30 ℔. nitrogen, 30 ℔. potash.

POTASH SERIES.

20. No potash, 30 ℔. nitrogen, 40 ℔. phosphate.
21. 20 ℔. potash as sulphate, 30 ℔. nitrogen, 40 ℔. phosphate.
22. 30 ℔. potash as sulphate, 30 ℔. nitrogen, 40 ℔. phosphate.
23. 40 ℔. potash as sulphate, 30 ℔. nitrogen, 40 ℔. phosphate.
24. 40 ℔. potash as sulphate, no nitrogen, no phosphate.

COTTON SEED MEAL SERIES.

25. 3,000 ℔. cotton seed.
26. 600 ℔. cotton seed.
27. 300 ℔. cotton seed, 30 ℔. potash, no phosphate.
28. 300 ℔. cotton seed, no potash, 40 ℔. phosphate.
29. 300 ℔. cotton seed, 30 ℔. potash, 40 ℔. phosphate.
30. 300 ℔. cotton seed, 30 ℔. potash, 40 ℔. phosphate, 30 ℔. nitrogen.

SALT SERIES.

31. 100 ℔. salt alone.
32. 200 ℔. salt alone.
33. 100 ℔. salt, 30 ℔. nitrogen, 30 ℔. potash, 40 ℔. phosphate.
34. 200 ℔. salt, 30 ℔. nitrogen, 30 ℔. potash, 40 ℔. phosphate.
35. 100 ℔. salt, 300 ℔. cotton seed.

SULPHATE OF COPPER SERIES.*

36. 20 ℔. sulphate of copper.
37. 20 ℔. sulphate of copper, 30 ℔. nitrogen, 30 ℔. potash, 40 ℔. phosphate.
38. 20 ℔. sulphate of copper, 300 ℔. cotton seed.

Note.

Plots nos. 5, 14, and 22, also nos. 8, and 13 are identical, so that one plot, that is, no. 5, will serve 5, 14, and 22, and one plot, that is, no. 8, will serve for 8 and 13.

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* See *Agricultural News*, Vol. III., p. 56, 'Rendering Plants immune against Fungus Parasites.'

RESULTS OF EXPERIMENTS.

On account of the drought or from other causes, some of these experiments were not carried to a successful conclusion. Useful returns have, however, been received relating to twelve series, the mean results of which are given in the table below.

YIELD OF SEED-COTTON IN POUNDS.

Average.

Experiment No.	Pounds per plot.	Pounds per acre.	Difference on no manure per acre.
1	20·31	812·4	......
2	21·04	845·6	+ 33·2
3	21·08	843·2	+ 30·8
4	20·95	838·0	+ 25·6
5	20·62	824·8	+ 12·4
6	21·22	848·8	+ 36·4
7	19·55	782·0	- 30·4
8	19·16	766·4	46·0
9	20·50	820·0	+ 7·6
10	21·94	877·6	+ 65·2
11	22·04	881·6	+ 69·2
12	21·21	848·4	+ 36·0
13	18·58	743·2	- 69·2
14	19·30	772·0	- 40·4
15	21·65	866·0	+ 53·6
16	22·26	890·4	+ 68·0
17	19·34	773·6	- 38·8
18	19·07	762·8	- 49·6
19	19·24	769·6	- 42·8
20	20·38	815·2	+ 2·8
21	17·70	708·0	- 104·4
22	19·70	788·0	- 24·4
23	17·65	706·0	- 106·4
24	19·97	798·8	- 13·6
25	20·17	806·8	- 5·6
26	19·15	766·0	- 46·4
27	19·94	797·6	- 14·8
28	24·87	994·8	+ 182·4
29	20·24	809·6	- 2·8
30	20·27	810·8	- 1·6
31	17·72	708·8	- 103·6
32	17·24	689·6	- 122·8
33	17·50	700·0	- 112·4
34	18·19	727·6	- 84·8
35	19·36	774·4	- 38·0
36	19·48	779·2	- 33·2
37	18·52	740·8	- 71·6
38	16·58	663·2	- 149·2

Owing to drought and other detrimental circumstances, the value of the information from the various plots varies. Dealing with the individual plots, perhaps more importance may be attached to the results obtained in St. Kitt's on La Guerite plots I and II, and in Montserrat on the plots at Dagenham's and White's. At these places the conditions were satisfactory and uniform, and the results were recorded with care. Mr. F. R. Shepherd, who had charge of the La Guerite plots, and Mr. C. Watson, who had charge of the Dagenham's and White's plots, both express the opinion that the manures had but little influence upon the yield of cotton.

The results of any individual plot are irregular and inconclusive, but on taking the average of all the twelve, it is seen that the irregularities tend to disappear. Satisfactory results in experiments of this kind will only be obtained by taking the average of a large number of experiments.

Dealing with the mean or average results of the twelve series, the differences are found to be strikingly small. If we assume that differences of 60 lb. of seed-cotton (equal to about 16 lb. of lint) per acre are too small to be taken into serious account, we find that only in thirteen cases out of the thirty-eight do the differences exceed this amount, and of these thirteen, six occur in the salt and sulphate of copper series, in which instances substances possibly injurious to plant life were employed in order to ascertain their effects upon insect or fungoid pests; and in these cases it is to be observed that diminished yields have occurred, indicating, probably, that salt and sulphate of copper both retard growth somewhat. It was not noticed that any particular immunity from disease was produced by the use of these substances. No explanation of the other seven cases of divergence from the average yield can be put forward, and it is not believed that they are related to the manures employed.

From these results we may draw the conclusion that the yield of Sea Island cotton is more influenced by season, by good soil condition and tilth than by artificial manures. At the same time it is well to remember that, while this may now be the case where cotton has been grown for the first time, it by no means follows that this will hold good in the future after cotton has been grown for some years upon the same areas.

These experiments will be repeated on somewhat similar lines for some little time to come, when it will probably be found that manures play an important part in connexion with soils which have borne a succession of cotton crops.

An interesting case occurred at Molineux, St. Kitt's, where a series of experiments was laid out. Here the rainfall is usually above the average of that of the Leeward Islands; in the season under review it was 51·5 inches for the six months July to December 1904. In this series the cotton plants grew to a very considerable size but produced so little cotton, that it was not practicable to weigh it; the results have not, therefore, been included in the table. This experiment is instructive and seems to point to the fact that cotton will not produce good

crops on rich lands subjected to a heavy rainfall, although the cotton bushes grow luxuriantly.

I desire to thank those who have assisted in these experiments, and to express the hope that they will again co-operate in similar experiments to be conducted upon the coming crop. Experiments conducted jointly by the Department of Agriculture and the planters are calculated to secure more confidence and attention than if they were conducted by the Department of Agriculture alone.

The writer's present views on the manuring of cotton in the Leeward Islands were given in the *Agricultural News* (Vol. IV, pp. 182 and 198) as follows:—

MANURING COTTON FIELDS.

The yield of cotton is profoundly influenced by season and by the condition of the soil. Under the head of season may perhaps be included not only rainfall, but also exposure to wind; the cotton plant is very sensitive to wind and grows much more vigorously when sheltered.

The condition of the soil has a most important bearing; for its best development Sea Island cotton requires rather light soil and requires the soil to be in a good state of tilth. Good tilth can be obtained by the application of organic manures such as farmyard manure, compost, green dressings; therefore, in preparing for planting cotton care should be taken to see that the soil is in good condition, and, if necessary, one of the organic manures mentioned should be used. In experiments conducted in the Leeward Islands during last season, it was found that, in cases where the soil was in good condition, the yield of cotton was not increased by the application of artificial manures, though, doubtless, there are cases where the use of artificial manures will prove advantageous. However, in the earlier stages of the industry it will be safer if cultivators of cotton take care to keep their land in good general condition by the use of organic manures, than if they trust to the use of artificial manures to make good the defects of bad farming. Possibly, however, it may be found, after cotton has been grown for some time on the same land, that artificial manures can be usefully and profitably employed to make good defects in the soil which may not appear in the early stages of the industry.

There is little room for doubt that cotton will require careful attention in the matter of manuring. What is here sought is to indicate what may be considered the *natural* manures, the use of which the cultivator must not neglect while seeking a short cut to success by means of artificial ones. There are certain underlying, fundamental principles which will serve to guide the cotton planter, and on which he will be able to build up his practice, at the same time extending his knowledge of the applicability of all the various kinds of manures within his reach.

A sugar crop makes comparatively little demands upon the soil because of the return to the soil of a large quantity of

waste products, such as the trash and tops of the canes, which either go back directly to the soil or find their way back as pen manure. The mud or scum of the clarifiers and filter-presses carries back a large portion of the nitrogen and phosphate, while the ashes from the megass restore to the soil a considerable part of the mineral matter contained in the cane. The sugar itself carries away comparatively little of the fertilizing constituents in the soil: thus, with the help of comparatively little artifical manure, the sugar-cane has been cultivated in some instances for some two hundred years almost continuously on the same land.

A cotton crop makes some demands upon the soil if we take both lint and seed into consideration; but the nitrogen, phosphate, and potash, the substances usually considered in connexion with manurial questions, are nearly all contained in the seed, there being but very small quantities in the lint. This being so, it appears evident that a cotton crop will make but small demands upon the soil if the cotton seed is returned as manure, or if equivalent quantities of manure of other kinds are given. When, as is often advised, the bush of the cotton plant is burned to destroy pests, there will be some loss of nitrogen, but the mineral constituents will be returned to the soil.

In the article in the *West Indian Bulletin* (Vol. V, p. 223), it is estimated that a crop of 200 lb. of lint per acre will be accompanied by 443 lb. of seed. This figure is somewhat below that indicated by our experience in the Leeward Islands, where I would estimate rather over 500 lb. Taking the 443 lb. mentioned, it is found that this contains 15½ lb. of nitrogen, 7½ lb. of phosphoric acid, and 7 lb. of potash. The greatest demand on the soil will therefore be in respect of nitrogen, particularly as some nitrogen will be lost by burning the bush, and also as there is always a natural tendency on the part of the soil to lose some of its nitrogen. A dressing of about 500 lb. of cotton seed per acre will thus restore the plant food removed by a moderate crop of cotton, and if this is supplementary to the use of a moderate amount of organic manure, it will probably be all that is required,

It may, however, happen that cotton seed is not available or only in limited amounts, or that the amount of organic manure is limited; under these circumstances, the use of artificial or chemical manures may be desirable. For this purpose I would suggest a general manure like that mentioned on p. 57 of the pamphlet *A. B. C. of Cotton Planting*, but with rather less phosphate: the phosphate might, I think, be safely reduced to 40 lb., and the proper manure would be prepared by mixing 300 lb. of good superphosphate, 40 lb. of good sulphate of potash, and 100 lb. of good sulphate of ammonia. This mixture should be applied at the rate of 440 lb. per acre * or in proportionately small quantities when used in conjunction with cotton seed meal or the organic manures mentioned above

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* With superphosphate costing $22, sulphate of potash $65, and sulphate of ammonia $75 per ton, the above 440 lb. of mixture will cost $7·46.

Thus, for example, 250 lb. of cotton seed and 200 lb. of the above mixture would probably be a good manuring for a field in fairly good condition.

Manures for cotton should be given early. They may with advantage be placed in the furrow or 'hole' where the cotton seed is to be sown. Cotton seed so used should be applied about a month before the seed is sown, so as to allow the cotton seed used as manure to decay and become incorporated with the soil before the young plant springs up. Chemical manures should be applied about a week before seed sowing.

The oil which the cotton seed contains has no manurial value: on the contrary, it rather retards the decay of the seed, thus delaying the manurial action of the manure. It is not, however, seriously detrimental. Cotton seed from which the oil has been pressed is therefore somewhat more useful as manure, as it is concentrated by the removal of the oil and is rendered rather more rapid in its action.

In some cases, where animals are kept, it may be found more profitable to feed the cotton seed to animals and to use the resultant manure for the cotton fields. This is sound farming, provided that the needs of the cotton fields are honestly considered, that the manure from the animals is properly conserved, and some allowance made for loss and waste. It is in this connexion that the artificial manure mixture mentioned above may be made to play a useful part. The manure from the animals should be worked into the soil during its early preparation, and then a week or two before seed sowing a dressing of from 2 cwt. to 4 cwt. of the mixture should be given, according to circumstances.

While it is essential for successful cotton growing that the soil should be in good tilth and furnished with the necessary plant food supply, it is, on the other hand, necessary to avoid over-manuring, particularly with nitrogenous manures, such as sulphate of ammonia or nitrate of soda, or with farmyard manure. A few instances of this kind have been observed during the past season, where the result has been a very vigorous growth of stem and leaf, accompanied by a disproportionately small crop of flower, and consequently few bolls and little lint. The lint, too, appears to have suffered in quality, for a crop of cotton grown from Rivers' seed thus over-manured was described as 'clean, bright but coarse staple' and sold at 1s. per lb., while other cotton from the same seed, but not over-manured, was selling at 1s. 2*d*. At the same time I would point out that over-manuring is not a common fault. I fear, on the contrary, that, as stated by Mr. Lee, cotton is too frequently regarded as a 'botanical "pariah."' (See *Agricultural News*, Vol. IV, p. 103.)

With regard to the application of organic manures, such as farmyard manure, sea-weed compost, or crushed cotton seed, it should be observed that, as cotton is a rapidly growing crop, coming to maturity in a few months, manures of this description must be applied sufficiently early to permit of their thorough rotting and incorporation with the soil at an early stage of the growth of the cotton plant; they should therefore be worked

into the soil some time before the cotton seed is sown. Farmyard and similar manures should be used in a well-rotted and mellow condition. Planters accustomed to sugar-cane, a crop having a long growing period, and one in which the manurial effect of farmyard manure is expected to extend over some two to three years on account of ratooning, are liable to overlook the necessity for the thorough and rapid incorporation with the soil of organic manures in the case of a short-period crop like cotton.

Cotton Manurial Experiments, Leeward Islands.—Yield of Seed-cotton in Pounds.

Experiment No.	Antigua.			St. Kitt's.				Nevis.		Montserrat.			Average.		Difference on no manure in pounds per acre.
	Skerrett's.	Montpelier.	Comfort Hall.	Canada.	La Guerite. 1.	La Guerite. 2.	La Guerite. 3.	Cane Garden.	Round Hill.	Dagenham's.	White's.	Grant's.	Pounds per plot.	Pounds per acre.	
1	14·00	3·38	15·00	20·75	39·25	36·56	11·56	32·19	20·00	13·00	10·00	28·00	20·31	812·4	..
2	9·00	14·00	18·00	12·75	35·06	37·56	17·38	35·31	21·00	13·00	13·50	26·00	21·04	845·6	+33·2
3	11·00	12·31	11·50	17·00	35·25	40·90	17·19	31·75	20·00	12·00	17·00	27·00	21·08	843·2	+30·8
4	20·00	13·67	10·00	15·50	38·13	35·19	15·75	28·25	22·00	11·00	17·00	25·00	20·95	838·0	+25·6
5	15·50	11·38	9·50	16·50	32·19	36·56	17·13	29·19	24·09	16·00	16·50	23·00	20·62	824·8	+12·4
6	12·00	13·05	10·00	15·25	38·06	47·90	13·00	31·38	20·00	16·00	15·00	28·00	21·22	848·8	+36·4
7	8.00	13·30	10·00	14·00	28·44	35·50	10·38	31·00	23·00	15·00	15·00	31·00	19·55	782·0	−30·4
8	15·00	9·30	7·50	16·00	31·25	31·00	11·50	32·90	20·00	14·00	17·50	24·00	19·16	766·4	−46·0
9	9·50	11·73	8·00	22·75	31·50	22·19	10·56	35·25	24·00	13·00	18·50	39·00	20·50	820·0	+7·6
10	15·50	10·33	10·00	23·25	31·38	40·00	13·94	29·63	18·00	13·50	19·50	38·00	21·94	877·6	+65·2
11	8·00	8·75	15·00	36·25	37·90	34·90	9·50	30·19	24·00	13·50	16·50	30·00	22·04	881·6	+69·2
12	7·00	4·75	14·00	43·75	37·75	34·38	12·70	23·13	23·00	12·50	14·50	27·00	21·21	848·4	+36·0
13	15·00	1·76	10·50	16·00	31·25	31·00	11·50	32·90	20·00	12·50	11·50	29·00	18·58	743·2	−69·2
14	8·00	3·50	13·00	16·50	32·19	36·56	17·13	29·19	24·00	17·00	13·50	21·00	19·30	772·0	−40·4
15	6·00	12·39	7·50	31·25	43·00	30·56	10·56	27·06	25·00	11·50	17·00	38·00	21·65	866·0	+53·6
16	...	10·25	7·00	33·00	37·44	36·90	8·25	31·13	19·20	12·50	17·00	31·00	22·26	890·4	+68·0
17	8·50	5·56	8·00	22·00	33·70	33·94	6·19	33·70	20·00	13·00	17·50	30·00	19·34	773·6	−38·8
18	12·00	9·97	14·50	21·00	26·19	27·13	9·19	24·38	21·00	13·50	22·00	28·00	19·07	762·8	−49·6
19	14·50	3·64	9·50	19·75	22·44	36·63	11·44	28·38	24·00	17·00	19·00	24·00	19·24	769·6	−42·8

COTTON MANURIAL EXPERIMENTS, LEEWARD ISLANDS.—YIELD OF SEED-COTTON IN POUNDS.—(*Concluded.*)

Experiment No.	Antigua.			St. Kitt's.				Nevis.		Montserrat.			Average.		Difference on no manure in pounds per acre.
	Skerrett's.	Montpelier.	Comfort Hall.	Canada.	La Guerite. 1.	La Guerite. 2.	La Guerite. 3.	Cane Garden.	Round Hill.	Dagenham's.	White's.	Grant's.	Pounds per plot.	Pounds per acre.	
20	19·00	2·58	12·00	11·25	33·90	33·50	9·81	34·00	25·00	15·00	18·50	30·00	20·38	815·2	+ 2·8
21	10·50	3·25	12·00	15·25	31·63	36·75	10·25	28·25	19·00	12·50	12·00	21·00	17·70	708·0	− 104·4
22	11·00	7·31	11·50	16·50	32·19	36·56	17·13	29·19	24·00	9·00	14·00	28·00	19·70	788·0	− 24·4
23	...	4·19	5·50	19·50	29·00	21·56	10·00	31·75	18·00	13·50	14·00	26·00	17·65	706·0	− 106·4
24	9·00	5·05	9·50	25·75	33·70	34·63	11·70	38·81	17·00	14·00	14·50	26·00	19·97	798·8	− 13·6
25	8·50	3·41	12·00	28·25	38·70	28·90	11·19	31·06	20·00	16·00	21·00	23·00	20·17	806·8	− 5·6
26	6·50	3·86	9·00	40·50	31·31	35·25	10·44	27·94	14·00	15·00	16·00	20·00	19·15	766·0	− 46·4
27	7·50	12·51	8·00	40·75	26·94	37·38	5·06	22·63	22·00	14·50	13·00	29·00	19·94	797·6	− 14·8
28	17·00	16·47	10·00	40·75	44·00	32·18	12·13	25·44	24·00	13·50	12·00	51·00	24·87	994·8	+ 182·4
29	14·50	15·05	5·50	37·25	34·75	22·50	9·06	31·81	23·00	14·50	12·00	23·00	20·24	809·6	− 2·8
30	7·50	8·91	9·50	23·75	37·94	44·06	6·94	31·70	18·00	15·00	13·00	27·00	20·27	810·8	− 1·6
31	3·50	3·20	7·00	25·75	29·94	37·75	5·13	24·31	19·00	16·00	15·00	26·00	17·72	708·8	− 103·6
32	1·00	2·45	4·50	12·75	34·25	35·50	5·06	23·38	22·00	15·00	16·00	35·00	17·24	689·6	− 122·8
33	6·50	2·94	7·50	15·00	31·00	30·25	7·56	27·81	20·00	16·00	18·50	27·00	17·50	700·0	− 112·4
34	4·50	1·84	8·00	36·75	29·44	24·75	7·25	30·75	19·00	16·00	16·00	24·00	18·19	727·6	− 84·8
35	14·00	9·31	6·50	25·00	35·25	24·38	8·38	32·06	22·00	16·50	14·00	25·00	19·36	774·4	− 38·0
36	10·00	19·25	7·50	19·75	27·19	40·81	6·19	26·13	20·00	18·50	13·50	25·00	19·48	779·2	− 33·2
37	11·00	9·61	8·00	20·00	38·38	33·06	10·19	27·50	21·00	16·50	12·00	15·00	18·52	740·8	− 71·6
38	2·50	4·00	6·00	17·25	33·18	35·90	12·06	20·56	23·00	20·00	12·50	12·00	16·58	663·2	− 140·2

MANURIAL EXPERIMENTS WITH CACAO AT DOMINICA.*

BY THE HON. FRANCIS WATTS, C.M.G., D.Sc., F.I.C., F.C.S.

In 1900 a plot of cacao in the Botanic Station of about 1¾ acres in extent was divided into five plots for manurial experiments as follows:—

No.	Letter on station plan.	No. of trees per plot.	Manure.
1	C.	34	No manure.
2	A.	37	Basic phosphate 4 cwt. per acre. Sulphate of potash 1½ cwt. per acre.
3	B.	40	Dried blood 4 cwt. per acre.
4	E.	34	Basic phosphate 4 cwt. per acre. Sulphate of potash 1½ cwt. per acre. Dried blood 4 cwt. per acre.
5	D.	39	Mulched with grass and leaves.

The cacao trees were about ten years old and planted about 18 feet apart. The chemical manures were applied once in each year, from 1900.

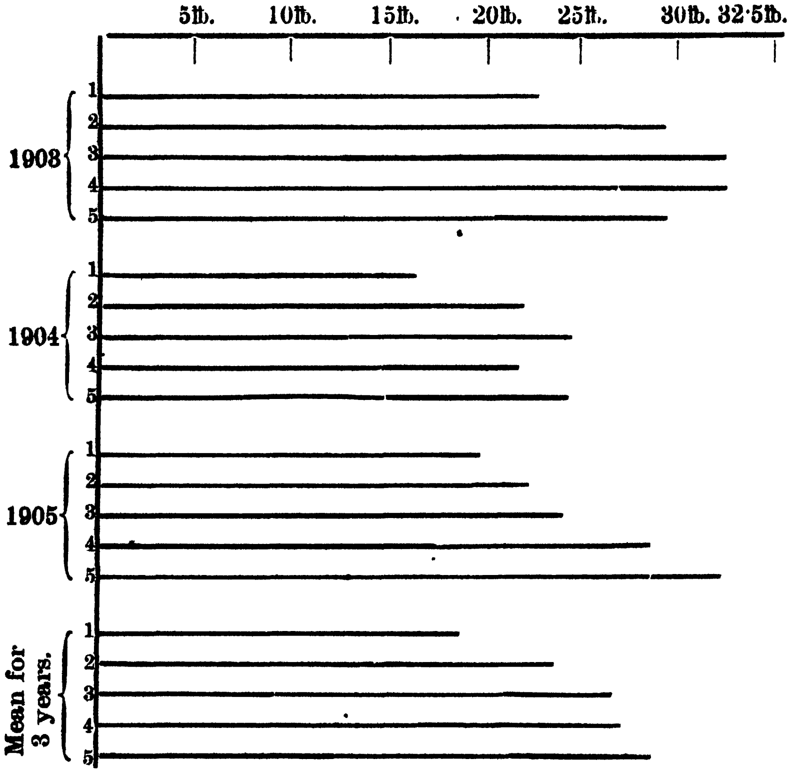
The weight of *wet* cacao has been recorded for each of the years ending June 30, 1903, 1904, and 1905. The results are as follows:—

* These experiments were carried out in association with Mr. Joseph Jones, Curator of the Botanic Station at Dominica. [Ed. *W.I.B.*]

YIELD OF WET CACAO IN POUNDS.

No.	Manure.	1903.		1904.		1905.		Mean of three years.		Difference on no manure.	
		per plot.	per tree.	per plot.	per tree.	per plot.	per tree.	per plot.	per tree.	per plot.	per tree.
1. C.	No manure	759	22·3	548	16·11	673	19·76	660·0	19·41	. .	...
2. A.	Phosphate and potash	1,063	28·7	808	21·83	814	22·00	895·0	24·19	+235·0	+4·78
3. B.	Dried blood	1,281	32·2	970	24·25	970	24·25	1073·7	26·85	+413·7	+7·44
4. E.	Dried blood, phosphate, and potash ...	1,104	32·4	738	21·70	979	28·79	940·3	27·65	+280·3	+8·24
5. D.	Mulched with grass	1,145	29·3	962	24·60	1,279	32·79	1128·7	28·95	+468·7	+9·50

The results based on the yield per tree, are also given in diagrammatic form for convenient comparison.



These experiments differ from those conducted with annual or short-period crops in that the effects are cumulative, the experiments are repeated on the same plot of ground and on the same individual trees year after year, and the results of several years have to be taken into account in estimating the effect.

The first point which strikes one is that all the manures used have proved beneficial. In the first two periods (1903 and 1904), while the mixture of phosphate and potash, and the dried blood both gave substantial increases in the crop, the combination of all three in 1903 only gave about the same return as dried blood alone, while in 1904 the return was even less where all three were given than where dried blood alone was used. This is anomalous and points to some disturbing influence.

The position of affairs in the third season is interesting and important. Here we find the smallest yield given by the plot receiving no manure, namely, 19¾ lb. of wet cacao per tree, the addition of phosphate and potash increased the yield to 22 lb., a gain of 2¼ lb. per tree. Dried blood gave a yield of 24½ lb., a gain of 4½ lb. over no manure and 2¼ lb. more than phosphate and potash. The combination of dried blood with

phosphate and potash increased the yield to 28¾ lb. per tree, a gain of 9 lb. per tree over no manure, of 6¾ lb. over phosphate and potash, and of 4½ lb. over dried blood. The combination of the two sets of manures has given greater increments than the sums of the increments from either singly, thus pointing to the necessity for general manuring, that is, for manure which will supply potash, phosphate, and nitrogen. The changes which have taken place in the soil during the previous three or four years probably account for the relative effects of the manures in this third period.

The plot mulched with grass and leaves, the sweepings of the lawns at the Botanic Station, is a very interesting one. In the first period this plot, though giving a greater yield than the no-manure plot, fell far behind the plot receiving dried blood; in the second period it again exceeded the no-manure plot and was practically equal in yield to, or a little better than, the dried blood plot; while in the third period (1905) it has far surpassed all the other plots and has given a yield 66 per cent. greater than that obtained from the no-manure plot. The soil of this plot is in better condition than the others, the surface soil is moister and darker in colour, while the trees have a better surface root development.

This method of manuring by means of mulches of grass and bush is evidently the proper course to adopt in Dominica, where, owing to the large supplies of the required material which are available, the work of manuring can be carried out efficiently.

These experiments again emphasize the desirability in the tropics of following agricultural methods which lead to the conservation of humus or vegetable matter in the soil. In most cases, if these methods are conscientiously adopted, sufficient supplies of plant food will be conveyed to the soil to obviate the necessity of buying artificial manures.

These experiments should be carried on for a number of years when further interesting results may be expected. It is probable that the plot mulched with grass and leaves will retain its vigour and productiveness for a much longer period than the others.

As 100 lb. of wet cacao are found to yield 42 lb. of dry cacao, and as the trees are planted about 18 feet apart, or at the rate of 134 trees per acre, approximate calculations may be made as follows * :—

* Some vacancies occur in the plot, so that the calculations have been made on the yield per tree rather than that per acre. The calculations per acre based on these are necessarily only approximations, but they are made for the sake of more ready appreciation of the commercial bearing of the experiments.

YIELD PER ACRE IN 1905.

No.	Pounds dry cacao per acre.	Gain over no manure in pounds.	Value of increase over no manure (at 6*d*. per lb. of dried cacao).		Cost of manure.*		Gain by manuring.	
			s.	d.	s.	d.	s.	d.
1	1,112	—	—		—		—	
2	1,288	126	63	0	45	3	17	9
3	1,365	253	126	6	36	0	90	6
4	1,620	408	204	0	81	3	122	9
5	1,845	733	366	6	60	0	306	6

The general yield of the cacao plot in the Botanic Station has been very satisfactory, even on the portion receiving no manure: from the work now carried on it is evident that proper care and manuring can be relied upon to give substantial increases in yield. These experiments therefore appear to possess a considerable amount of interest and value for Dominica cacao planters as indicating the lines upon which they should carry on their work from the earliest stages.

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* Taking manures at the following prices locally:—Basic phosphate, 5*s*. 6*d*. per cwt.; sulphate of potash, 15*s*. 6*d*. per cwt.; and dried blood, 9*s*. per cwt.; and assuming that so large a sum as £3 a year be spent on mulching, an estimate which appears very liberal

THE SOILS OF MONTSERRAT.

BY THE HON. FRANCIS WATTS, C.M.G., D.Sc., F.I.C., F.C.S., and
H. A. TEMPANY, B.Sc., A.I.C.

Montserrat is a volcanic island of comparatively recent origin, viewed from the geological standpoint; no sedimentary rocks have been observed there with the exception of a small amount of coral in the cliffs in the south-east corner of the island.

A number of samples were taken, under directions from the Government Laboratory for the Leeward Islands, by the Curator of the Botanic Station, and these have been examined in this laboratory. In each case samples were taken from various parts of the field to the depth of a foot and mixed together so as to obtain a sample fairly representative of a large area. Although, so far, only twelve samples have been examined, they serve to indicate, in a general manner, the chief characters of the soils of the island.

In each sample of soil there have been determined* :—

The phosphoric acid soluble in 1 per cent. citric acid solution ;

The potash soluble in 1 per cent. citric acid solution ;

The carbon dioxide evolved on treatment with hydrochloric acid;

The total nitrogen ;

The carbon existing in the form of organic matter.

These being the components upon which, from a chemical point of view, the fertility of soils chiefly depends, it would appear that the determination of these is sufficient to enable one to judge of their capabilities and requirements.

In order that the chemical results may be readily interpreted, the following arbitrary standards in connexion with each constituent may be employed to determine whether a constituent may be regarded as present in large or small quantity :—

Assimilable potash	Above	·01	per cent.	High.
„ „	·005 to	·01	„ „	Medium amount.
„ „	less than	·005	„ „	Low.
Assimilable phosphate	Above	·02	„ „	High.
„ „	·01 to	·02	„ „	Medium amount.
„ „	less than	·01	„ „	Low.
Carbonates in terms of carbonate of lime	Above	·5	„ „	High.
„ „	·1 to	·5	„ „	Medium amount.
„ „	less than	·1	„ „	Low.

* The methods employed in the analyses are described in the Report on the Soils of Dominica issued by the Imperial Department of Agriculture for the West Indies, 1903.

Nitrogen	Above	·15 per cent.	High.
„	·1 to	·15 „ „	Medium amount.
„	less than	·1 „ „	Low.
Organic matter	Above	2 „ „	High.
„ „	1 to	2 „ „	Medium amount.
„ „	less than	1 „ „	Low.

In addition to the chemical analysis each sample has been submitted to mechanical analysis by Osborne's beaker method. The results of this are given in figures and also diagrammatically for more easy comparison.

The diagrams represent the composition of the 'coarse sample' actually analysed, and do not include the stones, which are removed prior to analysis: the diagrams, therefore, correspond with the tubes in which the separated constituents are preserved for demonstration and reference.

The separated constituents are classed as follows:—

	Size of particles. *Millimetres.*	*Inches.*
Coarse gravel... .	5 to 2	·2 to ·08
Gravel	2 to 1	·08 to ·04
Coarse sand	1 to ·5	·04 to ·02
Medium sand... ...	·5 to ·25	·02 to ·01
Fine sand	·25 to ·1	·01 to ·004
Very fine sand ...	·1 to ·05	·004 to ·002
Silt	·05 to ·01	·002 to ·0004
Fine silt	·01 to ·005	·0004 to ·0002
Clay	less than ·005	less than ·0002

GROVE ESTATE.

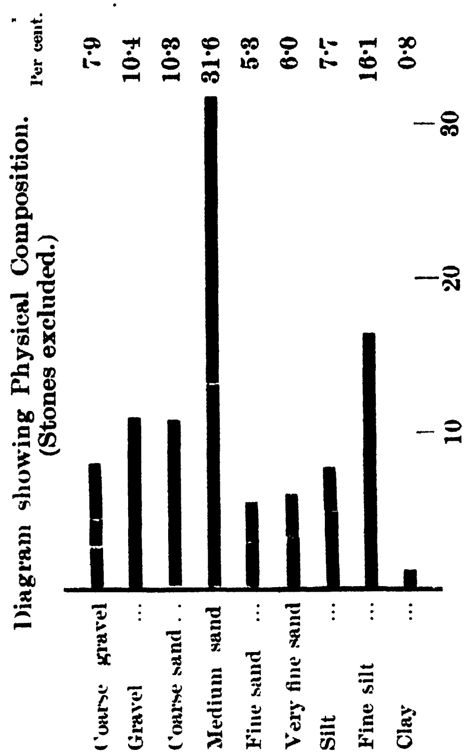
The Grove estate is situated about a mile to the north of the town of Plymouth, at an elevation of about 150 feet above the sea. Four samples were taken from various parts of the Botanic Station, which is located on this estate; the mixture of these may be taken as fairly representing the soil within the station itself and also, to a large extent, that of the surrounding estates of Grove, Dagenham, and Richmond.

Chemical Analysis.

Phosphoric acid soluble in citric acid solution	·023	per cent
Potash „ „ „ „ „	·018	„ „
Carbon dioxide	·012	„ „
Equal to carbonate of lime	·027	„ „
Nitrogen	·087	„ „
Organic carbon	·846	„ „
Equal to humus	1·460	„ „

PHYSICAL COMPOSITION.

Stones	16·2
Coarse gravel ...	6·6
Gravel	8·7
Coarse sand ...	8·6
Medium sand ...	26·5
Fine sand ...	4·4
Very fine sand	5·0
Silt	6·5
Fine silt . . .	13·4
Clay	·8
Organic matter and combined water	3·3
	100·0



Agricultural clay (= Fine silt and clay)	14·2
Water retained by flooding and draining per 100 of *dry* soil	39·5

The soil of the Grove Botanic Station is a light one, containing relatively little fine silt and clay; this character is shared by the soils in the immediate neighbourhood.

The chemical analysis reveals the presence of but a very small amount of carbonate of lime, a constituent somewhat readily washed out from sandy, free-draining soils. The nitrogen and humus are also low, lower in fact than might have been expected under the circumstances, for organic manures have been used somewhat freely.

Available phosphate and potash are present in fairly large amounts; for most crops there does not appear to be any necessity for the use of manures specially calculated to supply these two substances.

This soil is a light, easily worked one; in such a soil organic matter is likely to decay with considerable rapidity so that the use of pen manure or green dressings is advisable.

Where orchard crops, such as limes, are grown on these soils, the careful use of weeds as a mulch may be looked to to maintain the supply of humus and to improve the soil.

In its present condition, that is, while containing a fair amount of humus, the soil is moderately retentive of moisture.

GAGE'S.

This estate lies in the hollow between Chance's mountain on the south and St. George's Hill on the north. The sample for analysis was taken from a field near to the south-east from the sugar works, at an elevation of 600 feet. The sample analysed had the following composition :—

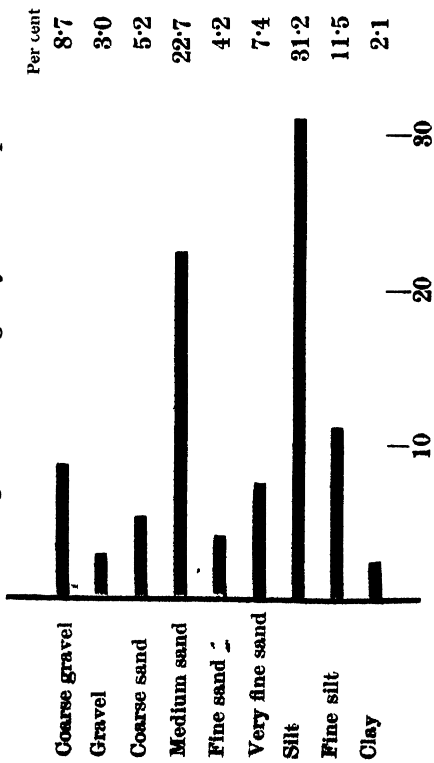
Chemical Analysis.

Phosphoric acid soluble in citric acid solution	0·0183	per	cent.
Potash " " " " "	0·0124	"	"
Carbon dioxide	0·034	"	"
Equal to carbonate of lime	0·076	"	"
Nitrogen	0·107	"	"
Organic carbon	0·809	"	"
Equal to humus	1·395	"	"

Physical Composition.

Stones	13·2
Coarse gravel ...	7·5
Gravel	2·6
Coarse sand ...	4·5
Medium sand ...	19·7
Fine sand ...	3·6
Very fine sand ...	6·4
Silt	27·1
Fine silt ...	10·0
Clay	1·8
Organic matter and combined water	3·6
	100·0

Diagram showing Physical Composition.



Agricultural clay (=Fine silt and clay)	11·8
Water retained by flooding and draining per 100 of dry soil	41·0

Assimilable phosphate and potash are both present in reasonably large amounts, so that manures specially supplying phosphates and potash are not necessary. Carbonate of lime is deficient in quantity. Nitrogen and organic matter are present in moderate amount: as these are liable to loss by decay, the use of pen manure or green dressings will prove beneficial.

The physical analysis indicates a soil easily worked and moderately retentive of moisture. Such a soil is a good, all-round one, suitable for cane, cotton, corn, limes, and most of the ordinary West Indian crops, provided that the rainfall and exposure are satisfactory.

LEES.

Lees estate adjoins Gage's and also lies in the hollow between Chance's mountain and St. George's Hill, at about the same elevation. The sample for analysis was taken from a field on the north side of the high road at the foot of St. George's Hill.

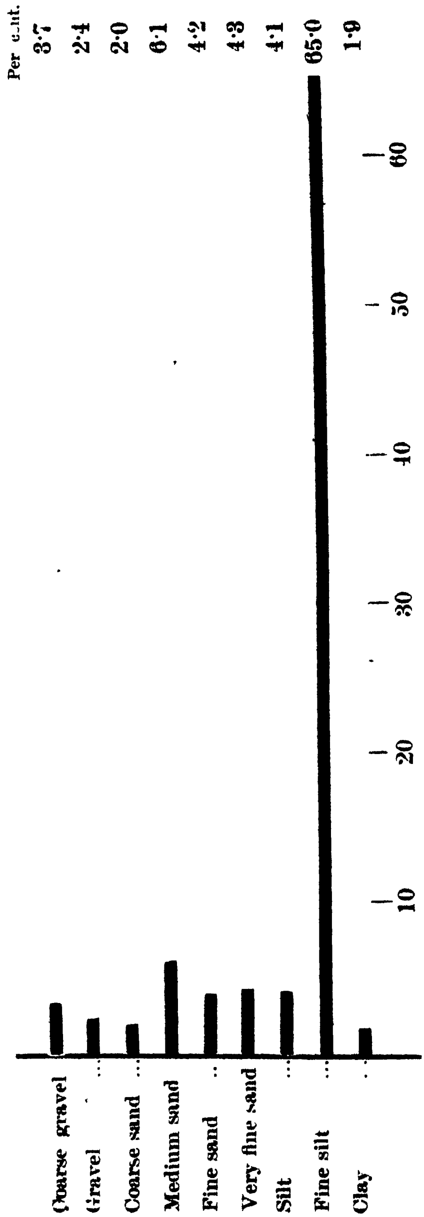
Chemical Analysis.

Phosphoric acid soluble in citric acid solution	0·0169	per cent.
Potash " " " " "	0·0155	" "
Carbon dioxide	0·014	" "
Equal to carbonate of lime	0·032	" "
Nitrogen	0·113	" "
Organic carbon	0·918	" "
Equal to humus	1·561	" "

PHYSICAL COMPOSITION.

Stones	3·2
Coarse gravel ...	3·6
Gravel	2·3
Coarse sand ...	1·9
Medium sand ...	5·9
Fine sand ...	4·1
Very fine sand ...	4·2
Silt	4·0
Fine silt	62·8
Clay	1·9
Organic matter and combined water	6·1
	100·0

Diagram showing Physical Composition.



Agricultural clay (= Fine silt and clay) 64·7

Water retained by flooding and draining per 100 of dry soil 57·0

This soil contains a moderate amount of organic matter and of nitrogen. Assimilable phosphate is present in moderate amount, while the assimilable potash is high. The amount of carbonate of lime is very small.

In physical character this soil is very different from those previously described, in that it contains but small quantities of the gravelly and sandy constituents, fine silt largely predominating. The agricultural clay amounts to 64·7 per cent. The large amount of fine constituents is due to the situation of Lees estate in a hollow, so that during heavy rain it receives accumulations of fine earth instead of losing these finer constituents by washing.

Unless kept in good condition by constant tillage and the supply of a reasonable quantity of organic matter, this soil is liable to revert to the condition of a stiff clay: this liability is accentuated by the small amount of carbonate of lime. It is retentive of moisture and capable of yielding good crops of sugar-cane, yams, potatos, and such things as thrive upon stiff soils.

Pen manure or green dressings are necessary in order that good tilth may be maintained; these will also supply all the elements of plant food required for most crops, so that the use of artificial manures, except of nitrogenous manures for ratoon canes, is not necessary. Lime in any form is desirable, but, unfortunately, lime for agricultural purposes, either in the form of burned lime or carbonate, is not obtainable in Montserrat at prices which permit of its profitable use.

FARRELL'S.

This estate is situated about the middle of the island on the main road leading from Plymouth to the windward coast and at about the highest point of the road. The sample was taken from a field near the high road and lying north-west from the sugar works, at an elevation of about 1,130 feet.

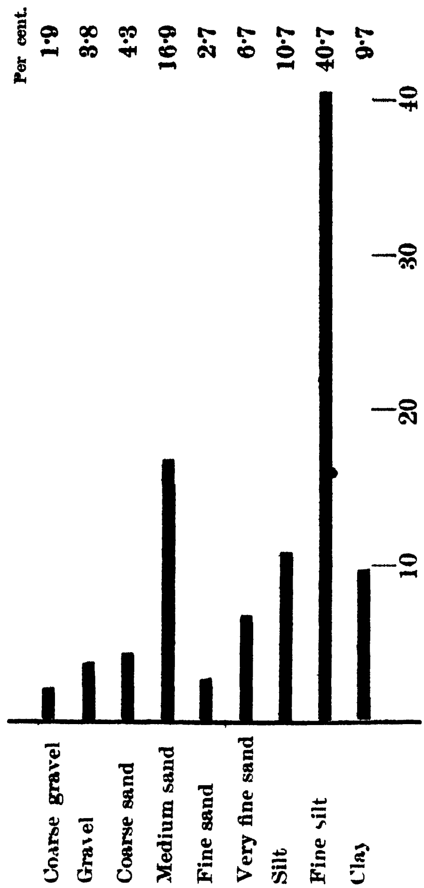
Chemical Analysis.

Phosphoric acid soluble in citric acid solution	0·0052	per cent.
Potash " " " " "	0·0155	" "
Carbon dioxide	0·018	" "
Equal to carbonate of lime	0·041	" "
Nitrogen	0·143	" "
Organic carbon	1·169	" "
Equal to humus	2·015	" "

PHYSICAL COMPOSITION.

Stones	7·4
Coarse gravel	1·7
Gravel	3·5
Coarse sand	4·0
Medium sand	15·6
Fine sand	2·5
Very fine sand	6·2
Silt	9·9
Fine silt	37·7
Clay	9·1
Organic matter and combined water	2·4
	100·0

Diagram showing Physical Composition.



Agricultural clay (= Fine silt and clay) 46·8

Water retained by flooding and draining per 100 of dry soil 50·1

The chemical analysis shows that the assimilable potash, the nitrogen, and the organic matter are all present in somewhat large and sufficient amounts; assimilable phosphate is low, and the carbonate of lime very low.

From the physical analysis it appears that the soil is loamy, having a fair amount of sandy constituents, thus producing a soil easily worked and maintained in good tilth, retentive of moisture and of manure.

HARRIS.'

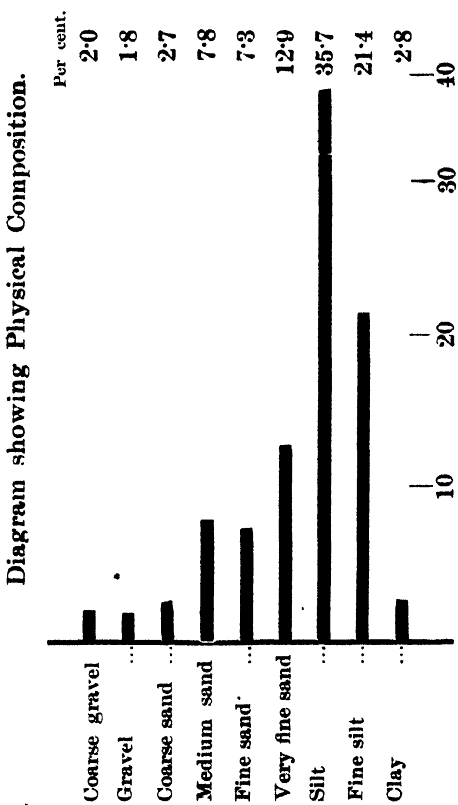
The sample for analysis was taken from four places in the Botanic Station at Harris': this is situated on the eastern or windward slope of the island at an elevation of about 970 feet.

CHEMICAL ANALYSIS.

Phosphoric acid soluble in citric acid solution	0·0088	per cent.
Potash „ „ „ „ „	0·0117	„ „
Carbon dioxide	0·064	„ „
Equal to carbonate of lime	0·145	„ „
Nitrogen	0·180	„ „
Organic carbon	0·897	„ „
Equal to humus	1·546	„ „

PHYSICAL COMPOSITION.

Stones	2·0
Coarse gravel ...	2·0
Gravel	1·8
Coarse sand ...	2·6
Medium sand ...	7·6
Fine sand ...	7·1
Very fine sand ...	12·6
Silt	35·0
Fine silt	21·0
Clay	2·8
Organic matter and combined water	5·5
	100·0



Agricultural clay (= Fine silt and clay)	28·8
Water retained by flooding and draining per 100 of dry soil	57·6

Here the assimilable potash is present in considerable quantity, but the assimilable phosphate is low. The carbonate of lime is present in larger amount than is usually met with in Montserrat soils, though even here the quantity is very small.

Nitrogen and organic matter are both present in medium amounts.

The physical composition of the soil is good. There is a satisfactory blending of sands with the finer constituents, giving rise to a loamy soil, easily worked and easily kept in order. Such a soil is capable of growing almost any of the common West Indian crops. Pen manure or green dressings will supply all the manurial requirements.

TRANT'S.

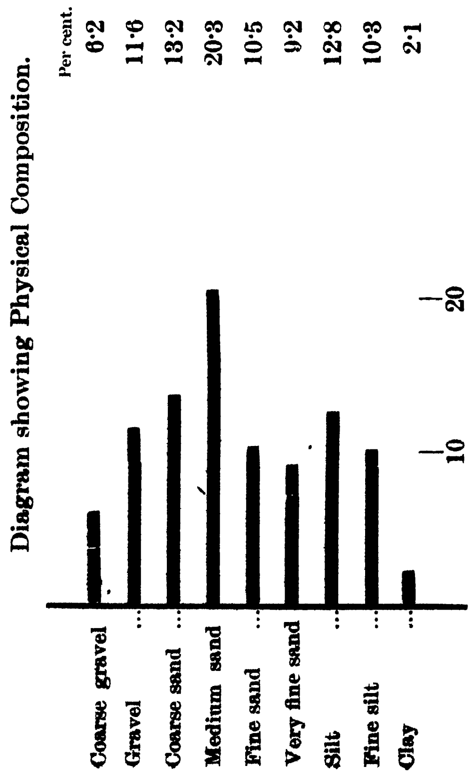
This estate is situated on the windward coast, much of the land being at a comparatively low elevation. The sample for analysis was taken from a field to the east of and near to the sugar works, and thus represents the low land.

Chemical Analysis.

Phosphoric acid soluble in citric acid solution	0·0449	per cent.
Potash " " " " "	0·0883	" "
Carbon dioxide	0·030	" "
Equal to carbonate of lime	0·068	" "
Nitrogen	0·138	" "
Organic carbon	1·436	" "
Equal to humus	2·475	" "

Physical Composition.

Stones	4·9
Coarse gravel ...	5·9
Gravel	11·0
Coarse sand ...	12·5
Medium sand ...	19·3
Fine sand ...	10·0
Very fine sand ...	8·7
Silt	12·2
Fine silt ...	9·8
Clay	2·1
Organic matter and combined water	3·6
	100·0



Agricultural clay (= Fine silt and clay)	11·9
Water retained by flooding and draining per 100 of dry soil	34·4

This soil is remarkable for the large amounts of available phosphate and available potash which are present, both of these being far in excess of the quantities usually found in the soils of these islands. The nitrogen and organic matter are also present in moderately large amounts. The amount of carbonate is, however, very small.

The physical analysis indicates that the soil is a light, almost sandy one; in places it is somewhat stony.

This soil is one which can be easily worked and easily kept in good order. From the proximity of the estate to the sea, sea-weed is readily obtained for use as manure; this should be collected and used whenever possible. The use of pen manure and green dressings is also desirable. If cotton is grown there will also be available a supply of valuable manure resulting from the cotton seed.

Taking these facts into account, there should be no difficulty in maintaining the fields of this estate in a high condition of fertility. From the proximity to the sea it may be possible to increase the carbonate in the soil by the use of coral or shell sand. The use of burned lime does not appear desirable; it would probably increase the fertility for a time, but on light soil of this description it would doubtless lead to rapid exhaustion of the organic matter, with consequent ultimate diminution of fertility. A large amount of humus is desirable in this soil to enable it to withstand drought, for it is not very retentive of moisture, a fact to be taken into consideration in its management.

This soil is eminently suitable for the cultivation of cotton. both from its situation and its composition. It will also carry good cane crops, and the same may be said of corn, sweet potatos, and the like.

BETHEL.

This estate is situated on the windward coast, its cultivated land rises from the sea to a moderate elevation lying higher than the land at the adjoining estate, Trant's.

The samples for analysis were taken from a field to the north-east of and near to the sugar works, at an elevation of about 200 feet. It was remarked that parts of the field are stony, while others are comparatively free from stones.

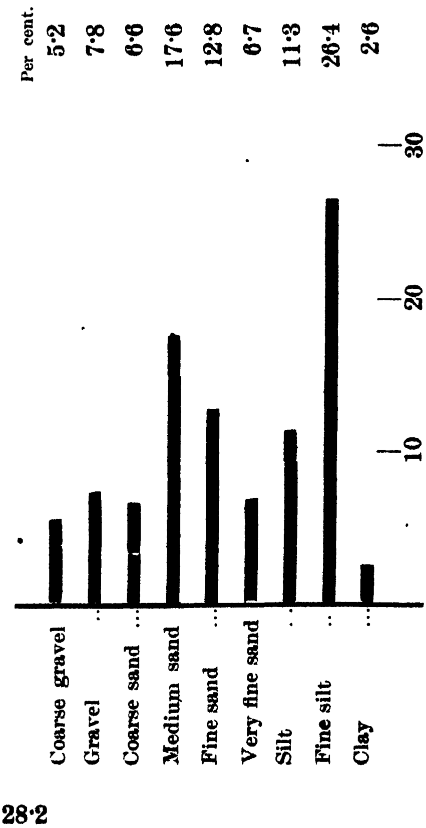
Chemical Analysis.

Phosphoric acid soluble in citric acid solution	0·0108	per cent.	
Potash „ „ „ „ „	0·0230	„	„
Carbon dioxide	0·022	„	„
Equal to carbonate of lime ...	0·050	„	„
Nitrogen	0·090	„	„
Organic carbon	0·757	„	„
Equal to humus	1·305	„	„

Physical Composition.

Stones	3·0
Coarse gravel ...	5·0
Gravel	7·6
Coarse sand ...	6·4
Medium sand ...	17·0
Fine sand ..	12·4
Very fine sand ...	6·5
Silt	11·0
Fine silt	25·6
Clay	2·6
Organic matter and combined water	2·9
	100·0

Diagram showing Physical Composition.



Agircultural clay (= Fine silt and clay)	28·2
Water retained by flooding and draining per 100 of dry soil	39·5

This soil is characterized by a high proportion of assimilable potash with a moderate, or small, amount of available phosphate; carbonate of lime is present in very small quantity, the nitrogen is low, and the organic matter is present only in moderate amount.

The physical analysis indicates a good type of soil, the coarser and finer constituents being well balanced.

The use of organic manures such as pen manure, sea-weed, 'bush' and green dressing is called for, rather than artificial manures.

This soil is a remarkably fertile one, and with the use of organic manures it can be maintained in a high condition of fertility without difficulty. It is adapted to the successful growth of the usual West Indian crops such as cotton, sugar, corn, yams, potatos, etc.

WHITE'S.

This estate is situated about a mile to the south of Bethel on the windward coast and has a similar aspect and exposure to that estate. The samples for analysis were taken from a field about 300 yards south of the sugar works. In some places the field is very stony, in others the stones are less abundant.

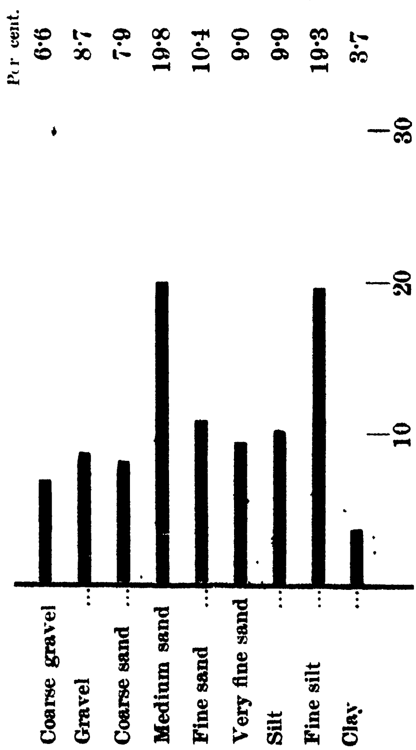
Chemical Analysis.

Phosphoric acid soluble in citric acid solution	0·0115	per cent.
Potash „ „ „ „ „	0·0164	„ „
Carbon dioxide	0·011	„ „
Equal to carbonate of lime ...	0·025	„ „
Nitrogen	0·099	„ „
Organic carbon	0·836	„ „
Equal to humus	1·441	„ „

Physical Composition.

Stones	2·4
Coarse gravel ...	6·4
Gravel	8·5
Coarse sand ...	7·7
Medium sand ...	19·3
Fine sand ...	10·1
Very fine sand ...	8·8
Silt	9·7
Fine silt	18·8
Clay	3·7
Organic matter and combined water	4·6
	100·0

Diagram showing Physical Composition.



Agricultural clay (= Fine silt and clay)	22·5
Water retained by flooding and draining per 100 of dry soil	38·9

In many respects this soil resembles that at Bethel, containing about the same amount of available phosphates, of nitrogen, and of organic matter: it is, however, poorer in available potash and only contains one half of the amount of carbonate of lime present at Bethel: in this constituent it is very deficient.

The physical character of the soil is good, and with the use of organic manures, as suggested for Bethel, this soil can be maintained in a high degree of fertility. Most of the ordinary West Indian crops such as cotton, sugar, corn, and the like could be grown without difficulty.

TAR RIVER.

This estate is situated on the windward coast to the south of White's. The samples for analysis were taken from a field to the south-east of the works. In places the field is very stony but stones are less abundant in others.

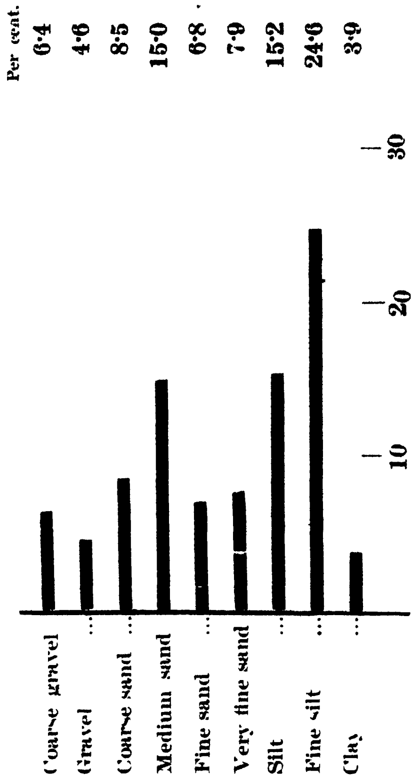
Chemical Analysis.

Phosphoric acid soluble in citric acid solution	0·0117 per cent.
Potash " " " " "	0·0077 " "
Carbon dioxide	0·030 " "
Equal to carbonate of lime	0·068 " "
Nitrogen	0·207 " "
Organic carbon	1·486 " "
Equal to humus	2·560 " "

Physical Composition.

Stones	11·6
Coarse gravel ...	5·7
Gravel	4·1
Coarse sand ...	7·5
Medium sand ...	13·3
Fine sand ...	6·0
Very fine sand ...	7·0
Silt	13·4
Fine silt	21·7
Clay	3·4
Organic matter and combined water	6·3
	100·0

Diagram showing Physical Composition.



Agricultural clay (= Fine silt and clay)	25·1
Water retained by flooding and draining per 100 of dry soil	46·4

This soil contains moderate amounts of assimilable phosphate and potash; carbonate of lime is present in very small quantity. Nitrogen and organic matter are present in relatively large quantities.

The physical character of the soil is good, consisting of a well-balanced mixture of fine and coarse constituents; it is consequently retentive of moisture.

In its present condition, owing largely to the considerable quantity of nitrogen and of organic matter, this soil should prove a very fertile one, capable of producing any of the ordinary West Indian crops. This fertility may be readily maintained and increased by the judicious use of organic manures such as pen manure, sea-weed, green dressings, or 'bush.'

WEEKS.'

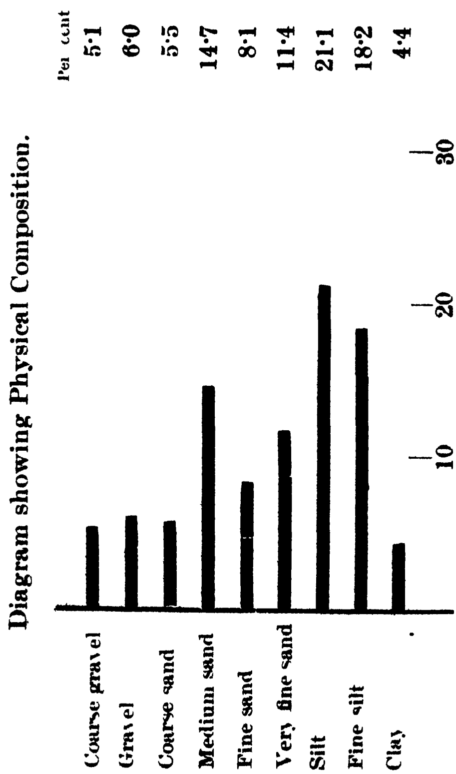
This estate lies on the northern slopes of St. George's Hill, at an elevation of about 600 feet and at a distance of about 2 miles from the town of Plymouth. The samples for analysis were taken from a field to the south-east of the sugar works.

CHEMICAL ANALYSIS.

Phosphoric acid soluble in citric acid solution	0·0164	per cent.
Potash „ „ „ „ „	0·0235	„ „
Carbon dioxide	0·089	„ „
Equal to carbonate of lime	0·088	„ „
Nitrogen	0·169	„ „
Organic carbon	1·214	„ „
Equal to humus	2·093	„ „

PHYSICAL COMPOSITION.

Stones	10·2
Coarse gravel	4·6
Gravel	5 4
Coarse sand ...	4·9
Medium sand ...	13·2
Fine sand ...	7·3
Very fine sand ..	10·3
Silt	18·9
Fine silt	16·3
Clay	4·0
Organic matter and combined water	4·9
	100·0



Agricultural clay (= Fine silt and clay)	20·3
Water retained by flooding and draining per 100 of dry soil	51·7

There is a moderate amount of assimilable phosphate present in this soil; the amount of assimilable potash is large,

but as is the case with the soils of Montserrat generally, the proportion of carbonate of lime present is very small. Nitrogen and organic matter exist in rather large quantities, thus indicating considerable fertility.

The physical composition of the soil is very satisfactory, the various constituents, gravel, sand, and clay, being mingled in such proportions as to produce a soil which is easily tilled and easily kept in good order.

Here, again, the use of organic manures will serve to maintain the high fertility which now exists.

Any of the ordinary West Indian crops could be grown to advantage in this soil, including limes, sugar-cane, cotton, corn. The introduction of well-arranged belts of trees as wind-breaks would probably render it possible to extend the range of crops to the inclusion of such as cacao, rubber, and the like.

ILES' BAY.

This estate, which is now cultivated in limes, is situated on the western or leeward coast: it rises from the sea to an elevation of 200 or 300 feet. The samples for analysis were taken from the lowlands near to the lime works.

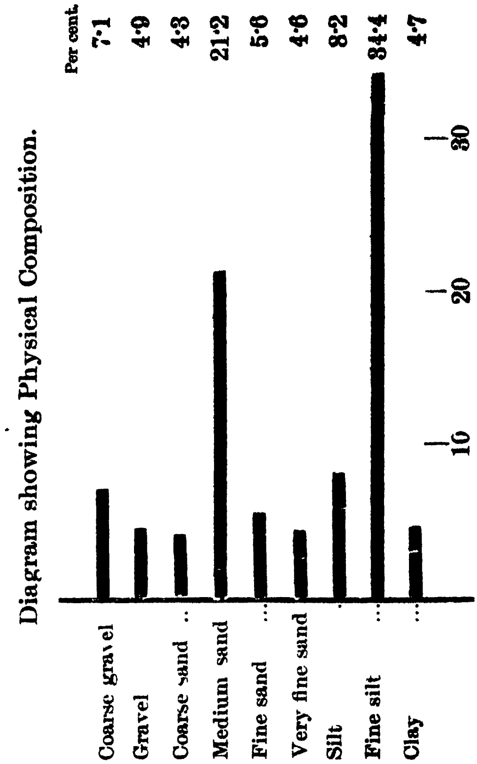
Chemical Analysis.

Phosphoric acid soluble in citric acid solution	0·0149	per cent.
Potash „ „ „ „	0·0077	„ „
Carbon dioxide	0·033	„ „
Equal to carbonate of lime	0·075	„ „
Nitrogen	0·146	„ „
Organic carbon	1·053	„ „
Equal to humus	1·815	„ „

The usual deficiency of carbonate of lime occurs here as elsewhere; in other respects the soil is a fertile one, containing a moderate amount of assimilable phosphate and potash, as well as of nitrogen and of organic matter; no special need for artificial manures appears to exist.

Physical Composition.

Stones	1·2
Coarse gravel ...	7·0
Gravel	4·9
Coarse sand ...	4·3
Medium sand ...	20·9
Fine sand ...	5·5
Very fine sand ...	4·6
Silt	8·1
Fine silt	33·9
Clay	4·7
Organic matter and combined water	4·9
	100·0



Agricultural clay (= Fine silt and clay) } 38·6

Water retained by flooding and draining per 100 of dry soil } 54·5

A considerable amount of very fine silt (agricultural clay) is present, but this is modified by the existence of a relatively large amount of sand. In the absence of sufficient organic matter this soil would probably set somewhat hard. An adequate amount of organic matter may be maintained without difficulty by the use of mulches of weeds and bush: the use of pen manure, if available, will be beneficial. This soil should prove a fertile one and one which can be maintained in good condition without difficulty.

OLVESTON.

The samples for analysis were taken from the Experiment Station on Olveston estate at an elevation of about 800 feet above sea-level and represent a somewhat extensive area situated on the lower, western slopes of the range of hills marked on the Admiralty chart as 'Centre Hills.' These soils, for the most part, consist of stiff clays, of which that at Olveston is typical.

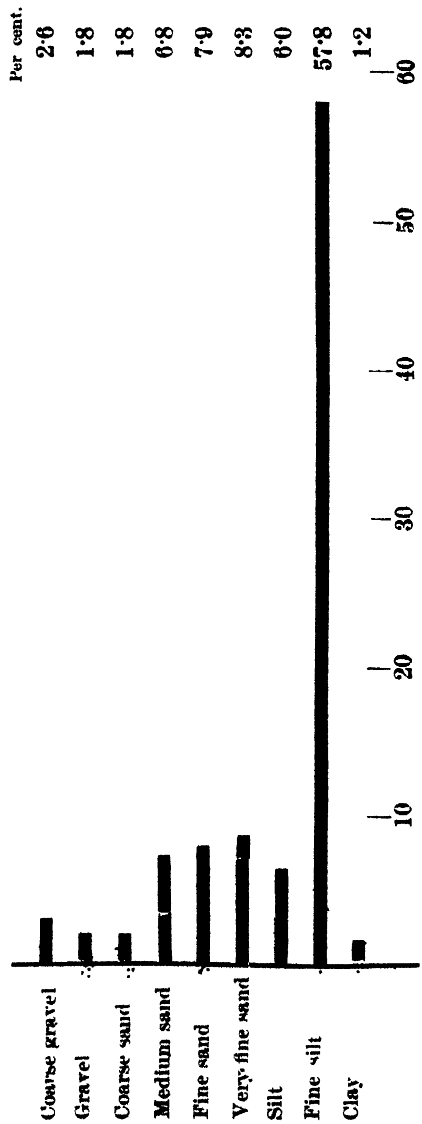
Chemical Analysis.

Phosphoric acid soluble in citric acid solution	0·0067	per cent.
Potash " " " " "	0·0103	" "
Carbon dioxide	0·031	" "
Equal to carbonate of lime	0·070	" "
Nitrogen	0·109	" "
Organic carbon	0·913	" "
Equal to humus	1·574	" "

Physical Composition.

Stones	2·8
Coarse gravel . .	2·5
Gravel	1·8
Coarse sand ...	1·8
Medium sand . .	6·6
Fine sand ..	7·7
Very fine sand ..	8·1
Silt	5·8
Fine silt	56·1
Clay	1·2
Organic matter and combined water	5·6
	100·0

Diagram showing Physical Composition.



Agricultural clay (= Fine silt and clay)	57·3
Water retained by flooding and draining per 100 of dry soil	58·2

The usual deficiency of carbonate of lime is found here. In a heavy soil such as this the absence of carbonate of lime renders the clay stiff and difficult to maintain in tilth. The elements of plant food, represented by assimilable phosphate and potash and by nitrogen and organic matter are all present in moderate, but not large, amounts.

The physical analysis reveals a large quantity of very fine silt (agricultural clay), with comparatively small quantities of coarse particles, thus the soil is, as already stated, a stiff one, somewhat difficult to work. Soil such as this calls for thorough tillage with abundant applications of organic matter: on a small scale this is best given in the form of well-rotted pen manure. The use of pen manure, of bush, and of green dressings is all-important in maintaining the tilth of soil of this kind. For arable crops advantage will probably be derived from lying fallow for a time in order to permit of a free growth of grass, the abundant roots of the grass tend to break up the clay and when the grass, with its roots and herbage, is well ploughed in, it adds, by its decay, substantially to the supply of humus and materially improves the condition of the soil. Green dressings of pigeon peas, Bengal beans, sweet potatos, Guinea corn, etc., are likely to prove useful. For orchard crops, like limes, surface mulchings with grass, weeds, compost, etc., are advisable.

Good dressings of lime, either as burned lime or as carbonate, would prove useful here, but, unfortunately, lime cannot be obtained at prices which render its use profitable.

The minerals observed were such as are likely to be derived from andesite and hypersthene-andesite. Hypersthene is a common constituent, present in every case. Ordinary, brown hornblende is common, while green augite occurs frequently. A mineral having the optical characters of aegerite also occurs commonly. Quartz, probably of secondary origin, is frequently met with. The felspars are largely plagioclastic, these, probably, are chiefly labradorite and anorthite. The felspar crystals are usually built up in numerous zones in a characteristic manner. In the samples from Bethel and Trant's small quantities of orthoclase were found. It is to be noted that the assimilable potash is relatively high at these places.

The present report leaves the soil of some districts unmentioned; a considerable amount of work is required to complete the survey: the work already done serves, however, to illustrate the general nature of the soils of the island.

The soils of Montserrat are, on the whole, fertile and easily worked; they are characterized by containing very small amounts of carbonate of lime, but otherwise, they are not usually deficient in the elements of plant food.

As the use of many forms of artificial manure tends to exhaust the carbonate of lime in the soil to which they are applied, the deficiency noted here might be of importance, should circumstances render the use of these manures necessary; fortunately, at present they do not appear necessary, except where ratoon sugar-canes are grown, where some nitrogenous manure, such as nitrate of soda or sulphate of ammonia, will prove useful.

There is considerable variation in the texture of the soils; in some instances they are sandy, in other cases they are heavy and stiff, requiring care in working. On the slopes of the hills the soil is frequently somewhat shallow.

Montserrat affords facilities for the cultivation of a great variety of crops. It has long been known for its extensive plantations of limes, for the cultivation of which it is very well adapted; there is an abundance of land suitable for lime cultivation and the industry is capable of considerable extension.

Sugar, formerly the staple industry, is readily grown, the island possessing a considerable quantity of land suitable for the growth of sugar-canes. Unfortunately, the course of events in connexion with sugar, and the extreme depression in prices of a few years ago, have led to the partial abandonment of sugar growing. The difficulties lie rather in the direction of sugar manufacture than of sugar growing.

There are large areas capable of producing Sea Island cotton of the finest quality, and during the past two or three years cotton growing has become firmly established. This industry is likely to increase and to become the principal one of the island. The lighter lands at no great elevation are most suitable for cotton growing: the records of the physical characters of the soils here published show that soil of the kind required is to be found extensively in Montserrat. As the climatic conditions are very favourable, the industry may be expected to extend rapidly and considerably. It is worth noting that the majority of the soils examined are eminently suited for cotton growing.

Suitable sites exist for the cultivation of cacao and of rubber, both of which are deserving of increased attention. The introduction of lines of trees, systematically planted as permanent wind-breaks, will be necessary and important adjuncts to the cultivation of these and other trees. By the introduction of wind-breaks the areas suitable for the cultivation of fruit or tree crops, such as cacao, rubber, limes, and oranges, may be increased enormously.

The light, sandy soils are suitable for the cultivation of pine-apples which can be very readily raised.

Montserrat offers facilities for the successful cultivation of provision crops and of vegetables. As there is much good land lying at a considerable elevation, up to and above 1,000 feet, it is possible to cultivate to advantage an extensive range of vegetables in addition to the usual sweet potatos, yams, and corn; such vegetables as onions, cabbages, carrots, turnips,

and peas can be successfully grown, and the mere enumeration of these will indicate the capabilities of the island.

With the development of limes, cotton, and sugar as staple industries, opportunities should arise for the extension of other industries for which the soil and climate of Montserrat afford ample facilities.

GRAPE FRUIT AND SHADDOCKS.

The following popular notes on varieties of grape fruit and shaddocks, by Sir Daniel Morris, K.C.M.G., D.Sc., D.C.L., appeared in *Garden and Forest*, an American horticultural journal published at New York, April 22, 1896.

Recently applications for information in regard to the respective merits of grape fruits and shaddocks were received from the Board of Agriculture in the Bahamas and other sources, and with the view of placing the facts on record in an accessible form, they are re-reprinted in the pages of the *West Indian Bulletin*:-

During my recent visit to New York I was much interested to notice the considerable demand that existed there for grape fruit,* from the West Indies. It appears to be very strongly recommended by the medical faculty for its refreshing and tonic properties, and, in consequence, the use of it has become an important feature in the diet in American cities. The fruit I saw in New York called grape fruit consisted of various sorts and qualities, and there is little doubt that much confusion exists as to what is really grape fruit as distinct from the allied citrus fruits passing under such names as Pumelow,† Shaddock, Forbidden fruit, Paradise fruit and others. The chief characteristics of all these fruits, distinguishing them from the different varieties of the orange, are associated with the size and colour. They are all, or nearly all, larger than the largest orange, and they are uniformly of a pale-yellow colour. In texture the rind may be smooth or even polished. It is seldom rough, nearly always firm and not very thick. The pulp is pale yellow or greenish-white, sometimes pink or crimson. The vesicles of the pulp (juice bags) are more distinct than in the orange; very juicy, somewhat sweetish, with a distinct, but agreeable, bitter

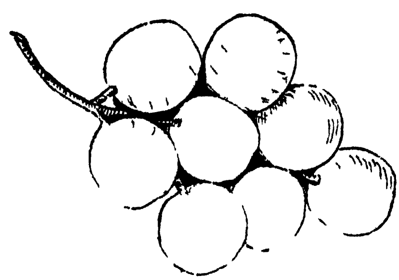


FIG. 1. GRAPE FRUIT.

*It is so called because the fruits grow in clusters like a bunch of grapes.
†It is invariably spelled Pomelo in the United States.

flavour. The pith surrounding the segments possesses more of the bitter than the pulp, but is less agreeable, and on that account is never eaten. In shape these fruits vary a good deal. Some are quite globular, others somewhat flattened at the top and tapering below, forming a pear-shaped body. Even in the globular fruits the top is more or less flattened. There are none, I believe, pointed at both ends.

Having indicated the general characters of this class of citrus fruits, I may venture on a brief sketch of their origin and history. It is agreed by all authorities that these fruits are quite distinct from the other groups of the orange family, such as the true oranges and the citrons. They have, therefore, been kept apart and ranged under the Giant Citrus, *Citrus decumana*. In this species the tree is 12 to 18 feet high, with a flat crown and spreading branches, usually with no spines. The leaves are elliptic-rounded at both ends, emarginate (that is, with a notch at the apex) and crenulate (having the edge marked with small depressions); the under side of the leaf is softly hairy, with the wings broad, crenulated as in the leaves, and bordered with fine hairs. The flowers are in clusters of from three to nine, large, white, and fragrant. The fruit is either globose or pear-shaped, forming many seedling varieties without distinct names. This is supposed to be a native of the islands of the Pacific, whence it had been brought to southern China, Japan. and India. It was introduced to the West Indies, according to Macfadyen, from China by Captain Shaddock, whose name has since been given to it. The term shaddock may be correctly applied to any of the larger members of the giant citrus, and is equivalent to the French pompelmouse, which is another form of the Dutch pomplemoes. The word pomelow, so widely used in India and Ceylon, is supposed to be a contraction of 'pomum melo,' the melon apple. The largest 'pumelows' in India are said to reach '2 feet in circumference and weigh 10 to 20 ℔.' The best sort, according to Bonavia, is 'the thin-skinned, red pumelow of the Bombay market.' This is of a globose shape, juicy, and 'of the colour of raw beef internally.' There are, however, numerous grades in size, some being almost as small as oranges. In India the varieties do not appear to have recognized names. Elsewhere the smaller fruits have been variously called Paradise apples, Forbidden fruit, and Grape fruit.

As regards the proper classification of the West Indian varieties, I cannot do better than record that put forth by Dr. James Macfadyen, the learned author of the *Flora of Jamaica*, which, however, he never lived to carry into more than one volume and part of another. Referring to the large-fruited sorts, he states: 'There are two varieties of shaddock. In the variety *a.*, *maliformis*, the fruit is globose, with the pulp of a pale-pink colour, approaching to a very light yellow. In the variety *b.*, *pyriformis*, the fruit is more or less pear-shaped, and the pulp is of crimson colour, more or less intense. The second of these varieties is the more esteemed, being sweet and juicy and having only in a slight and palatable degree the acridity which abounds in the first. I may remark that I have always found the pear-shaped variety good, whereas it is

seldom the case with the round-shaped fruit. There cannot be a doubt but that, if budding, as is done in China, were more generally practised, instead of trusting to propagation by seed, the fruit would be much improved.'

The smaller pumelows or shaddocks are ranged by Macfadyen under a distinct species, which he calls *Citrus paradisi.* The tree is described as 30 feet high, of handsome appearance, with sub-erect branches and sharp at the apex. The leaves are oval, rounded, and smooth on both sides. The flowers have linear petals and the stamens are twenty-five in number. The differences between this and *C. decumana* appear to consist in the more erect habit of the plant, in the rounded (not emarginate) leaves, and in the linear-rounded (not oblong-obtuse) petals. With regard to the fruit he remarks: 'There are also two varieties of this species: var. *b., pyriformis,* Barbados Grape fruit; var. *b., maliformis,* Forbidden fruit. The pear-shaped variety, as the shaddock, possesses most of the sweet principle, and is, on the whole, a preferable fruit.' This classification was made by Macfadyen nearly sixty years ago, therefore long before these fruits were so widely distributed as now in other parts of tropical America. He was so accurate and skilful an observer that, as far as the New World fruits are concerned, we cannot very well improve upon it. It is doubtful whether the small-fruited sorts he places under *C. paradisi* really deserve specific rank, but that point does not affect the main question with which we started, namely—What are the differences, if any, existing between the shaddock and grape fruit? In summing up the results of the investigation, we may say that all the larger-fruited sorts may be called indifferently either pumelows or shaddocks. These are merely the eastern and western names for the same thing, and are perfectly interchangeable. No distinction appears ever to have been made between them. There are two well-marked varieties, one being globose, with the flesh of a pale-pink colour, and the other pear-shaped, usually with a deep-pink or crimson pulp. As regards the small-fruited sorts, these, according to Macfadyen, may be either globose, when they are called forbidden fruit, or pear-shaped, when grape fruit is the older name. The name forbidden fruit (from a fancied connexion with the Garden of Eden) is tolerably old in the West Indies. Tussac, in the *Flore des Antilles*, published in 1824, gives a good figure of the typical shaddock, which he translates into the French *Chadec.* In Vol. III, pp. 73-4, he states: 'J'ai eu occasion d'observer a la Jamaique, dans le jardin botanique d'East, une espèce de Chadec dont les fruits, qui n'excedent pas en grosseur une belle orange, sont disposés en grappes; les Anglais de la Jamaique donnent à ce fruit le nom de "Forbidden-fruit," fruit defendu, ou smaller shaddock.' Later on he refers to the same fruit in the following words: 'C'est une assiette de dessert très distinguée et fort saine' (p. 74). In the case of the forbidden fruit and grape fruit they are exactly reversed. As usually happens, when a name has become familiar in commerce, it is eventually applied in a much wider sense than the original one. Thus, the term grape fruit has become so general that any moderately large fruit, provided the skin is pale-yellow, thin and smooth, and

the pulp of a delicate flavour, is designated by it. The fruit commonly called grape-fruit in New York is really the forbidden fruit of the West Indies. The true grape fruit is pear-shaped, and, according to Macfadyen, when obtainable at its best, is preferable to the forbidden fruit. The fruit shipped from the Bahamas as grape fruit is usually round, with a polished yellow skin of a silky texture and very heavy. This is probably one of the best of its class, and quite equal to Macfadyen's pear-shaped variety. Next comes some excellent fruit from Jamaica, no doubt that already referred to by Tussac under the name of forbidden fruit, a smaller shaddock. According to the New York estimation, this would be almost a typical grape fruit, supplying 'une assiette de dessert très distinguée et fort saine.'

Further information on the pumelow was contributed by Sir Daniel Morris to the *Gardeners' Chronicle*, 1896, Vol. II, p. 616, as follows:—

I have been asked more than once lately whether there is no fruit, yet unknown to most English palates, which might be introduced into this country, and form a pleasant article of food. As there seems to be some general interest in the subject, your readers may, perhaps, like to hear of some fruits which have come under my notice.

The pumelow of India, one of the giant members of the orange tribe, is well known to people who have lived in the East. Some very large specimens have been known to attain a circumference of more than 2 feet, and to weigh from 15 to 20 lb. Generally pumelows are not held in high esteem in India and Ceylon, except by those who have lived long there, and know how to select the best sort by their size and colour. The best Bombay pumelows are said to be exceptionally good. They have a pink pulp of a juicy character, sweet in flavour, with a slight but agreeable bitter taste. The first pumelows were brought to the West Indies by Captain Shaddock about 150 years ago. Since that time the fruit has always been known in that part of the world as the shaddock, in compliment to the person who introduced it. Owing to circumstances of soil and climate, and to the raising of plants almost exclusively by seed, many varieties have sprung up that have become recognized by distinct names. Of the larger fruits, the pumelow or shaddock proper, there are two well-marked forms; the first is the apple-shaped shaddock, usually with a whitish or a pale-pink pulp; the other is a pear-shaped fruit, with a pink, and sometimes a deep-crimson pulp. Both these are large fruits, weighing from 3 to 6 lb. in weight; they have the characteristic pale-yellow skin, and inside there is a white pithy layer more or less thick; then comes the pulp with the vesicles or juice-bags very prominent—indeed the latter are so distinct that they can be easily separated the one from the other. The bitter flavour is very marked in the inferior sorts; in some instances it becomes quite acrid. The best sorts have a sweetish flavour and only a slight taste of bitter. Of the smaller fruits, to which Macfadyen has given the name of Paradise fruits, there are in the West Indies two well-marked forms. The

apple-shaped fruits are known as forbidden fruit, while the pear-shaped sorts are known as Barbados grape fruit. Both these are very attractive-looking fruits; they have a pale-yellow skin usually very thin, are soft and silky to the touch, while the pulp is sweet and refreshing. The slightly bitter flavour is regarded as giving them tonic properties of great value in dyspepsia and allied ailments.

During the last fifteen years the Paradise fruits, or more correctly grape fruit, have been in great demand in the United States. They have been very strongly recommended by the medical faculty, and in consequence their use has become an important feature in the diet of a large number of the American people. The consumption of them has increased by leaps and bounds, and every year for the past few years it has more than doubled. A few days ago (says *Garden and Forest*) 2 barrels of small-sized grape fruit realized the extraordinary price of £5 each in New York; and 7 barrels of similar fruit were sold in Philadelphia for £5 10*s.* each. Such fruit would retail at more than $1·00 apiece. This is probably the highest price ever paid for specimens of the orange tribe. It shows very clearly how keen is the demand for grape fruit, and what importance is attached to it as a refreshing and healthful adjunct to the food supply of the United States. At one time there was a better market for grape fruit—or, rather, forbidden fruit, as it was called—in the United Kingdom than in America. But the tables are now turned. America, especially since the destructive frosts in Florida, has now absorbed almost the whole supply from the West Indies. Sooner or later, however, English people will realize the special merits of the grape fruit and a demand will arise for it, to the possible advantage of those West India Islands which are in a position to supply it. It would be well, therefore, for the people in that part of the world to establish small orchards of grape fruit trees of the best quality, and to be prepared to ship the fruit in such a condition that they may get the best price for it. This would be one way of alleviating, to some extent, the depression under which they are now suffering, owing to the unremunerative character of the sugar industry.

The following, containing further notes on grape fruits and shaddocks, was contributed by Sir Daniel Morris to *Chambers' Journal* of January 30, 1897.

Under the title of 'Paradise Fruits,' Dr. Macfadyen, many years ago, described some interesting members of the orange family. Their origin was not clearly traced, but there was little doubt that they had been produced by seed variation in the West Indies. Their nearest relations were the common shaddocks or pumelows (*Citrus decumana*). These are well known as the largest of the citrus fruits; some fine specimens have weighed as much as 20 lb., and measured 2 feet in circumference. According to Alphonse de Candolle, 'shaddocks and pumelows are probably natives of the islands east of the Malay Archipelago.' They were found in a wild state by Seemann and others in the Fiji Islands and the Friendly

Islands, so there is little doubt of their Polynesian origin. They are now distributed in most tropical countries, but, except in a few localities, they are not so highly esteemed, for instance, as the best oranges. Usually the skin is thick and pithy, and the pulp bitter, and there is little or no demand for them in commerce. The Paradise fruits, on the other hand, are in great demand, and they are regarded as the most refreshing and wholesome of any of the citrus family. Recently, in New York, some of the latter were retailed at almost fabulous prices, and the demand increases every year. The Paradise fruits, while they fall specifically under *Citrus decumana* or the giant Citrus, have many points of merit, not the least of which is the keen preference shown for them by the people of the United States. They are quite distinct from the true oranges, citrons, and other groups of the orange family.

The typical fruits of *Citrus decumana* are those known in India as pumelows (a contraction of *pomum melo*, the melon apple), called by the French Pompelmouse or Pamplemouse, and by the Spanish and Dutch Pompelmoes. As these fruits were first introduced to the West Indies by Captain Shaddock, in that part of the world they have always borne his name. Pumelows and shaddocks are only the Old and New World names for one and the same fruit. Sometimes it is stated that the largest fruits are called shaddocks, and the next in size pumelows. There is no authority for this distinction. In this place, I shall quote pumelows and shaddocks indifferently as convenient popular names for all the largest fruits of the typical *Citrus decumana*. A preference may unconsciously be given to the use of the word shaddock, but only because it is the most familar name in the West Indies. As regards the varieties of these fruits existing in different parts of the world, they are, for the most part, distinguished by the locality where they are grown rather than by any character they may possess. For instance, in India the best pumelow, according to Bonavia, is the thin-skinned, red pumelow of Bombay. This is a perfectly globose fruit, very juicy, and with the pulp of a rosy-red colour. The botanical characters of *Citrus decumana* are perhaps more marked than in any other species. The tree is larger; and both the young shoots and under side of the leaves are covered more or less with soft down. No other species of citrus has the latter characteristic. The tree may be as high as 20 feet, with a flat crown and many spreading branches. Usually there are no spines. The leaves are distinctly rounded at both ends, with a notch at the apex; the edges are uneven or wavy, owing to the presence of a number of small depressions; the stalk or petiole is furnished with two broad wings, also wavy, and bordered with fine hairs. The flowers are somewhat like those of the orange, but larger, and are both white and fragrant; they are usually in clusters of three to nine. The fruit is spherical or pear-shaped, very large, sometimes even as large as a man's head, and very heavy. The juice is always slightly acid, while the rind in the common sorts is remarkably thick with a bitter inner membrane. The vesicles containing the juice are very prominent and arranged transversely; in the orange they are hardly discernible.

Pumelows or shaddocks differ from other citrus fruits in size; they are invariably larger than the largest orange and, in addition, are compact and very heavy. In colour, they are pale-yellow, almost like lemons, but they differ from the lemon in having usually a smoother skin. The flesh is pale-yellow or greenish-white; in some sorts there is a tendency to pink or crimson, as in the so-called 'blood-oranges.' The pink-fleshed shaddocks, if otherwise acceptable, are more esteemed than the white-fleshed. They are said to be sweeter and more juicy, and have only in a slight and palatable degree the peculiar flavour of the ordinary shaddocks. Macfadyen, sixty years ago, stated that he always found the pear-shaped shaddocks better than the spherical sorts. His experience is not invariably endorsed at the present time. Some of the spherical fruits are of a very delicate flavour, and, as already mentioned, the best of the Indian sorts are not only spherical, but have also a pink flesh.

So far, I have described the fruits of the typical *Citrus decumana* only. When we come to the smaller fruits, we find that both in the tree yielding them, as well as in the fruits themselves, there are certain distinguishing features which show they are rightly separated by Macfadyen, although we cannot go so far as he has done in assigning the plant producing them specific rank. Macfadyen grouped the smaller fruits under *Citrus paradisi*, thus expressing his appreciation of them by designating them the fruits of Paradise. He distinguished two varieties, to which he gave the names of forbidden fruit and the Barbados grape fruit. He described the tree as of handsome appearance, about 30 feet in height, with branches sub-erect and sharp at the apex. It will be noticed that in the shaddock the tree was 20 feet high, with a flat crown and spreading branches. The leaves are oval, rounded, and smooth on both sides. The flowers have linear instead of oblong petals, and the stamens are twenty-five to twenty-six in number instead of thirty to thirty-five. The fruits, as in the shaddocks, are either spherical or pear-shaped. To the pear-shaped fruits were assigned the name of grape fruit, because they usually grew in clusters; while the spherical fruits were called forbidden fruit from a fancied connexion with the Garden of Eden. This classification was made by Macfadyen nearly sixty years ago, therefore long before these fruits were so widely distributed, as now, in various parts of tropical America. The forbidden fruit was known to Tussac in 1824, who called it 'Fruit Defendu or smaller Shaddock.' Later he refers to the same fruit in the following words: 'C'est une assiette de dessert très distinguée et fort saine.' With the exception of the shape, forbidden fruits and grape fruits are very much alike, but they are both superior to any shaddock or pumelow—the fruits of *Citrus decumana*—while the smaller and more delicate fruits bear the distinctive name of Paradise fruits. Of these the grape fruit is the one now so highly esteemed in the United States. The *Penny Cyclopaedia* had adopted a similar classification even in 1837. It is stated: 'When these fruits arrive at their greatest size, they are called

pompoleons or pompemousses; when at the smallest, they form the forbidden fruit of the English markets. Another small variety, with the fruit growing in clusters, is what the West Indians call grape fruit.'

The grape fruit is not a shaddock nor a pumelow. It is quite a distinct fruit, and possesses exceptional merits; at its best, it differs from the shaddock as much as a fine apple from a common crab.

We may be sure that such keen-witted men as the fruit merchants of New York would not give high prices for grape fruit unless it were in great demand and thoroughly appreciated by people able to pay for a choice and delicate article. It is estimated that there were received in the United States last year grape fruit of the value of about £20,000. The demand for it is quite of recent date, but it is increasing so rapidly that in a few years the grape fruit will be one of the most valuable of the citrus fruits in the New World.

There are, doubtless, many inferior sorts of grape fruit. In fact, in the West Indies the plants have been allowed to run almost wild. No care has been taken to select the best varieties, or to bud and graft them, so as to keep them uniformly at a high standard. *Garden and Forest*, the leading horticultural journal in America, very wisely advises that, 'wherever the fruit is grown, it should be borne in mind that the highest success will only come with the use of the best varieties. There is no need to grow the thick-skinned and bitter sorts, and those with a dry, cottony pulp, while there are varieties both of the apple-shaped and pear-shaped fruits with a silky skin, full of juice and of a most delightful flavour, with just enough bitter to give it piquancy and suggest its valuable tonic qualities.'

Mr. C. B. Hewitt gives the following account of the grape fruit:—'At one time it was not thought much of in Florida, being only eaten by the old Floridians as a spring tonic, and to drive away malaria. As soon as its great medicinal qualities were recognized, the doctors began to recommend it for indigestion, and also as an appetizer. The majority of people who eat this fruit do not like it at first, and many have not tried to like it, on account of the bitterness of the pithy membrane dividing the pulp. The correct way to eat this interesting fruit is to remove carefully this lining and to eat only the pulp. Some people prefer to cut the fruit open through the middle, take away the seeds, and then sprinkle a little sugar over the cut surface, and work it in with a spoon. Then let it stand for a little time, or overnight, and eat before meals.' 'There is nothing,' continues this writer, 'in the fruit line yet discovered that possesses the medicinal qualities of the grape fruit. The demand for it will increase from year to year, and take up all the fruit that will be grown for the next twenty years. As many as 6,000 fruits are said to have been gathered from a single tree. This was an exceptionally fine specimen. It was described as 49 feet in height, and 30 feet across its widest branches. It was thirty-four years old.' There are many

varieties of grape fruit, some seedless, or with an occasional seed only.

The grape fruit is in such great demand in America chiefly because it has been so highly recommended by the medical faculty for its valuable dietetic and tonic qualities. It is also very refreshing, and is regarded as a specific for dyspepsia. The Americans are large fruit-eaters, and seldom begin or end a meal without fruit of some kind. To supply them with bananas alone, there arrived from the West Indies during the year 1895, 185 cargoes of this fruit, comprising nearly 17,000,000 bunches, of the value of over £5,000,000 sterling. Jamaica furnished the larger share of this immense shipment of tropical fruit, and that island is becoming quite prosperous in spite of the great depression that has overtaken all the sugar-producing countries in that part of the world. Hitherto, Florida has supplied a good deal of the grape fruit for the American market, but since the disastrous effects of the 'freeze' of last year, the Florida plantations have been almost destroyed. Much English capital invested in fruit growing in that state has been lost, and many of our young countrymen settled there have suffered a severe reverse of fortune. Even where the groves are not quite destroyed, it will take years of toil and expenditure to bring them back to their former condition. For some time, at least, the chief supplies of grape fruit must therefore be drawn from the West Indies. The people in that part of the world would do well to establish trees of the best varieties, and take advantage of the opportunity to participate in what promises to be a steady and remunerative industry.

CACAO EXPERIMENTS IN CEYLON.

Recent reports by the Controller of the Experiment Station at Peradeniya, Ceylon, contain valuable information in regard to experiments with cacao which is likely to be of interest to cacao growers in the West Indies. The following are extracts from these reports:—

In 1903 the area in cacao at the station was reduced from 150 acres to 116 acres. The following table shows the progress and composition of the crops for the past three years:—

	Good pods.	Fungus pods.	Squirrel pods.	Green pods.	Total.
1902. (150 acres) ...	141,272	88,765	19,379	32,887	632,447
1903. (116 acres) ...	2[illegible]3,389	20,804	33,981	13,358	569,738
1904. (116 acres) ...	380,891	19,350	40,077	9,814	619,311

CANKER DISEASE EXPERIMENTS.

The routine disease work consisted of excising and burning the cankered tissue and the burning of all diseased pod walls.

It is to be noted that in 1904, as in 1902 and 1903, the maximum percentage number of fungus pods is related to the heavy rainfall. The maximum percentage of fungus pods does not correspond with the maximum crop period.

Relation between Rainfall and Disease.—There can no longer be any doubt as to this relationship. During June and July we had no less than 29·56 inches of rain, and canker work was almost at a standstill. During this period the mycelium was growing as quickly as it possibly could, and the expenditure of Rs. 2·33* and Rs. 1·14 per acre in August and September is sufficient proof of the rapidity with which the fungus had spread. The heavy rainfall occurred during months when very little mature fruit was on the tree, but fortunately, better weather prevailed during the cropping period from August to December. The maximum percentage number of fungus pods in July and August was associated with the heavy rainfall during June and July, but it is satisfactory to realize that the number of pods lost through disease at that time was small.

Relation between Cacao Canker and Crop.—In 1903, on the same acreage, our expenditure for canker work was

* Rupee: nominal value, 2*s.*; exchange, 1*s.* 4*d.* [Ed. *W. I. B.*]

Rs. 2,016·18, or Rs. 17·39 per acre per year. During 1904 the total expenditure on the same acreage has been Rs. 1,409·18, or Rs. 12·15 per acre per year. The expenditure under this heading has been reduced by about one third, and the fact that the crop for 1904 is 104 cwt. more than in 1903, or an increase of 76 per cent., is sufficient to show that the work carried on is more than paying for itself.

WIND-BELTS AND SHADE TREES FOR CACAO.

The necessity for either of these, the preference for shade as against wind-belt trees, or vice versa, and the best distance at which to plant them, have long been discussed by cacao planters.

Wind-belts.—The effect of wind has been studied on several plots from which the timber and shade trees have been entirely removed. The effect of strong winds, particularly during the months of January and February, is to produce partial or complete defoliation of the cacao trees. The leaves become brittle and dry and finally drop, and within a couple of weeks the greater portion of the shoots on the upper part of the stem are leafless. Some of the shoots burst into new leaf at a later date, but I have examined others which appear to have died in consequence of the hot, dry wind constantly playing over them. The twigs were simply dried. They bore no signs of fungus or helopeltis.

On particular areas the cacao trees were defoliated twice in the year, viz., February and September; such behaviour must result in the reduction or exhaustion of all reserve store materials within the plant, since the assimilatory organs are repeatedly destroyed and new leaf is manufactured at the expense of reserve material The cacao tree cannot stand such frequent defoliation, and the effects will be seen on the general health of the trees and their crop returns. Cacao trees under proper cultivation do not drop all their old leaves yearly, but show a net increase year by year. There is, further, the possibility of a too extensive destruction of flowers, the strong winds readily detaching the exposed delicate flowers, no matter whether they possess a fertile or infertile pistil.

The object in these experiments is to determine which species is the best wind-belt for cacao. Each wind-belt species is planted in the form of a square, each side measuring 40 yards. The plants are distanced 7 feet apart. All timber or shade trees and palms within 75 yards of any square will be removed, so that the effects of the selected wind-belt can be more accurately measured. The following have been chosen:—*Grevillea robusta*, Cunn.: coppiced *Michelia Champaca*, L.; *Pterocarpus echinatus*, Pers.; *Eugenia Jambos*, L.; areca nuts (*Areca Catechu*, L.) in three rows; *Filicium decipiens*, Thw., and *Castilloa elastica*, Cerv.

The above-mentioned species are all evergreen, and will form an effective wind-belt. The exclusion of wind from cacao may, have a deteriorating effect, and for this reason *Erythrina lithosperma*, Bl., has been planted as an experimental wind-belt of medium resistance.

Shade Trees.—The following species, each to be planted at a fixed distance apart, have been selected :—*Albizzia moluccana*, Miq., up to seven years old ; *Melia dubia*, Car. (lunumidella); *Erythrina lithosperma*, Bl. ; *Hevea brasiliensis*, Muell. (Para rubber) ; *Cassia multijuga*, Rich. ; *Enterolobium cyclocarpum*, Griseb. ; *Cassia nodosa*, Ham, ; *Pithecolobium Saman*, Benth. ; *Tectona grandis*, L. (teak) ; *Castilloa elastica*, Cerv. ; and cocoa-nuts.

These experiments are being carried out on plots 11 to 33 ; the remaining part of the cacao has been planted up with dadap (*Erythrina lithosperma*) at distances of 30 feet, and the boundaries of these plots planted with Jak (*Artocarpus integrifolia*) and sapu (*Michelia Champaca*).

The control plot will gradually be cleared, and nothing except cacao trees allowed to grow on it. Plot 44, 5 acres in extent, has been selected for this purpose and already it has become a congested centre of troublesome weeds. The experiments with wind-belts and shade trees necessitate a great deal of felling of extraneous trees, and the question of weeding on practically open land becomes very troublesome.

CACAO MANURIAL EXPERIMENTS.

Experiments have been carried out during the past year (1903) to determine the effect of excess of nitrogen, potash, and phosphoric acid, and the relative value of the more general manures and modes of cultivation.

The question of the relative importance of the essential ingredients—nitrogen, potash, and phosphoric acid—cannot be worked out on old cacao land as at present available, and, accordingly, special plots have been established for the purpose. The ground chosen is flat and relatively uniform in physical properties. All trees, palms, old cacao, etc., have been cleared and the land well drained. Seeds from an Amelonado variety have been sown at a distance of 20 feet by 20 feet apart. The seeds were obtained from the tree on one day and the young and irregular beans thrown away. The parentage, physical conditions, and drainage are therefore equal throughout the plot. Trees other than cacao will not be allowed to grow there. The plot is divided into four parts, one for each ingredient and one control. They have already received a small quantity of the necessary artificial manure, and the average height of the seedlings is about 18 inches.

There are no very striking differences to be noted beyond the active leaf production which occurred on plots treated with potash and nitrogen. The same treatment will be continued next year, when definite results will probably be obtained. The weeds on these plots developed at a rapid rate and were subsequently turned into the soil.

One tree on the plot treated with concentrated superphosphate dropped nearly all its leaves two months after the manure was applied ; there was very little disease on the tree, and the curious behaviour could not be accounted for except by temporary inactivity of the root system. Before the tree

dropped all its leaves the little canker present was excised. In a few weeks' time new leaves appeared, and the tree is now quite healthy. This tree was supplied with a very heavy dose of concentrated superphosphate, and a large portion of this soluble manure appears to have been readily absorbed and satisfied the requirements of the plant for a conspicuous period of time.

General manurial experiments have been carried out on plots of established trees, the plots chosen being fairly representative of those on cacao estates. The applications will be continued year by year until it has been proved which are best. The records of the yields on these plots are taken weekly, and in comparing the totals allowance must be made for the fact that the age of the trees on the different plots is at great variance, the varieties are numerous and in varying proportions, and different species of trees and palms exist in different proportions on the selected areas. These reasons are sufficient to prevent one becoming too positive as to the relative value of the different manures when the differences in yields are inconspicuous. When the plots have been more equalized, the results will, however, be of definite value to cacao growers.

The maximum crop has been obtained from the plot treated with excess of lime; this plot would probably have given the maximum crop without any lime, though the latter will probably exert a beneficial effect on the soil and lead to increased returns in future. Similar remarks might be made with respect to the plots treated with cattle manure and kainit. The only plot which has apparently responded in 1903 to the manure applied is that treated with basic slag and ammonium sulphate.

It is very difficult to define the effect of a given manure in terms of increased cacao crop in plots so unequal in parentage and occupied with trees other than cacao. This is obvious from the fact that the control plot, which was not treated in any way, gave a better crop than five out of the seven areas experimented with.

Furthermore, plot 1, which from its appearance suggested a healthy condition and promised a good crop, was eliminated from the experimental area, and, though never treated with manure, gave a crop of 10,334 fruits, equal to about 5 cwt. per acre. Other examples might be quoted to prove the same necessity for caution.

The plots were commenced in 1903 and repeated in 1904. Excepting those plots treated with excess of manures, the others have been treated on a basis of 50 lb. of each essential ingredient per acre. In nearly all cases the response to the manure is obvious, especially in connexion with excess of nitrogen, potash, and phosphoric acid.

GREEN MANURING IN CACAO.

The fact that most of the cacao in Ceylon is grown under partial shade makes it almost impossible to obtain good results with herbaceous green manures, owing to an insufficiency of

light. In cacao which is only lightly shaded, the use of *Vigna*, *Crotalaria*, and ground nuts can be recommended. For most cacao estates, however, green manuring can best be accomplished by using the plants grown to protect the cacao against wind and intense light. The tree forms already considered, *Erythrina lithosperma* and *Albizzia moluccana*, can be and are used in this way. The great difference compared with green manuring in tea is that in cacao the plants can be regularly lopped, rung, and resupplied at less frequent intervals than in tea. If they are allowed to grow without being lopped, they will become a danger to the cacao and aid in the spread of disease. It is obvious that the use of dadaps and Albizzias as sources of green manure in cacao does not necessitate entire removal of shade. It only means that the shade is maintained as desired and yet nothing allowed permanently to occupy the land except cacao. Furthermore, the frequent lopping of the trees used as shade will prevent the cacao trees from becoming too spindly. The advantage of having low, well-branched cacao trees is only too well known to planters, who have to harvest the crop as cheaply as possible and to keep all parts of the tree under observation in connexion with the diseases of this product.

CACAO DISEASE IN CEYLON.

The 'Canker' disease of cacao, which has proved a very serious menace to cacao cultivation in Ceylon, is met with in Trinidad, Grenada, and Dominica. Brief mention of it was made by Mr. L. Lewton-Brain, in his paper on the Fungoid Diseases of Cacao, published in this volume of the *West Indian Bulletin* (pp. 85-90).

The following article by Mr. Herbert Wright, Controller of Experiment Stations in Ceylon, appeared in the *Tropical Agriculturist* for August 1905. Mr. Wright shows that the fungus causing this disease can be successfully kept in check by rational agricultural methods:—

It is perhaps hardly necessary to state that cacao trees in Ceylon are subject to a fungus disease, a parasite which belongs to the same group of plants as those which practically swept out coffee and mitigated the cultivation of cinchona in this island. The disease on the cacao trees is one which, given favourable conditions of dense shade and abundance of moisture, spreads rapidly through the stem of the tree, and, sooner or later, attacks the pods irrespective of their age. We are in possession of facts which prove that the yield of cacao may be reduced within six or seven years from nearly 3 cwt. an acre to ¼ cwt. per acre. Such a check to the yield of a cacao estate is due to several causes. The first is the weakening effect of the fungus on the trees when once it has become thoroughly established. Most of the cacao plants when badly diseased have an unhealthy appearance, and when, as is often the case,

the fungus develops completely around the stem, the parts above the area of infection die. Spores of the fungus may be blown about by the wind and carried to the stems and fruit of other trees. Sometimes the fungus takes a more direct course, and permeating the stem enters the growing fruit. In any case the fruit-producing power of the tree is lessened : the young and old fruits become diseased, and the result is shown in the reduced crop.

When one considers how effective curative measures have proved in Ceylon and elsewhere, the necessity for immediate and continued work against our cacao disease is obvious. There are many ways by means of which the fungus can be kept in check, but only the methods that have been employed and found effective need be considered here. They are briefly as follows :—

(1) Letting in sunlight.
(2) Excision and burning of diseased tissues on the stem.
(3) Frequent collecting and burning of diseased fruits or burying with lime.
(4) Spraying with chemical compounds known to be poisonous to the spores of fungi.

True, many persons have spent much time and money in rubbing the excised areas with chemical compounds, coating with tar, and treating with powerful reagents; but these methods can be dealt with summarily in due course.

LETTING IN SUNLIGHT.

The power of the sun's rays in checking the ravages of many plant diseases has long been acknowledged. It would be difficult to find a better case in support of this than has been obtained with cacao in Ceylon. Dense shade on old cacao estates is usually correlated with the presence of the fungus disease, and examples can be quoted to show that if the other curative methods are adopted and sunlight not allowed to enter the trees, the disease is, after a period of three years, as bad, if not worse, at the end than at the beginning. As a case in point, it may be quoted that on one area where the excision, collecting, and burning of cankered tissue were subsequent to the thinning out of the shade, the yield of the cacao has been increased from 1 cwt. to approximately 5 cwt. per acre per year. On an adjacent area where the shade was allowed to remain dense, but the other curative methods were adopted, the yield has remained almost stationary, the increase being only in this case from $\frac{3}{5}$ to 1 cwt. per acre per year. The letting in of sunlight such as results from judicious thinning out of shade often prevents the spores of the fungus from germinating, and aids the tissues of the stems in their efforts to heal the wounds created by the excision of cankered areas.

EXCISION AND BURNING OF DISEASED BARK.

Since this work consists of the examination of stems and branches, the cutting out and burning of those parts which are found to be diseased, it comes second in importance as a means of eradicating the canker. It is far more important that this

work should be carried out than that money should be spent in spraying fruits, coating with tar or treating with strong acids and alkalies. The use of the knife is the only effective method of combating the disease on the stems and branches, and on most estates is the only curative measure adopted." It is obvious that the examination and treatment of the stem for disease is the most important item to be reckoned with in the cultivation of cacao in Ceylon, as, if it is allowed to develop, reduction in crop, followed by the death of the trees, is a certainty. Several examples are known where areas of cacao have never been treated for disease, and which have more or less successfully withstood the ravages of the fungus, and it is the existence of such local, circumscribed patches which have formed the butt of the arguments of the few anti-canker planters. Let us then examine the *pros* and *cons* of this curative method. The first and most serious argument against carrying out this work is that of expense. Experience has convinced us that on a cacao property which had been neglected for several years, and which had almost every tree affected with the fungus, an expenditure of Rs. 17 per acre was required for the first year, and an annual recurrent expenditure from Rs. 8 to Rs. 12 for each succeeding year if the canker has to be kept in check. It is difficult to understand why cacao planters should ever object to such an expenditure, when at the same time they allow sums of Rs. 8, and even more, per acre per year for the weeding of cacao estates.

It is not in the province of this article to deal with suggestive methods of cultivation for reducing the evil effects of weeding, but mention is made of this work to show that expenditure cannot really be the only objection against the burning and excision of diseased tissues, and to point out that expenditure on weeding in preference to canker work is probably against the interests of the industry.

A second objection often put forward is that the work of excision and burning cannot be kept up throughout the year, and therefore the rapid spread of the fungus during the wet months mitigates any good effects which might be accomplished during the dry part of the year. It is perfectly sound to assert that the adoption of excision work for a couple of months in the year is not followed by the best results; but it has yet to be proved that the weather conditions prevailing in cacao-growing districts are against the execution of this work, except during the dry season.

Generally speaking the months of June-July and October, November are too wet for effective canker work, and the labour is urgently required for planting operations. But during the other months in the year there are usually a large number of fine days when canker work can be done, and it is satisfactory to know that several cacao planters carry on the curative work during every month of the year if possible. If the canker work is not systematically continued during the dry weather of most months of the year, the expenditure is to some extent wasteful, as it can be shown that estates, which were so free from disease

as to cost only 50c. per acre per round, required, after an interval of two months, an expenditure of approximately Rs. 2 per acre per round. The frequent inspection of the trees prevents the fungus from obtaining too firm a hold and greatly reduces the cost per acre per round.

A third objection is that the coolies, by repeatedly scraping the stems with their knives in search of canker, aid, in no mean degree, the spread of the fungus spores. This may be an unavoidable evil, but it cannot be more serious than the carrying of spores on the clothes of the coolies, by animals, or by the wind, and can never form a sound enough reason for the cessation of the use of the knife. The best proof against this or any other objection is to be seen on any cacao property where excising and burning are efficiently carried out, as in all these cases not only are the fungus trees greatly reduced in number, but the percentage of black pods is much smaller and the crop is increased in quantity and quality far above the expenditure involved in executing the curative work.

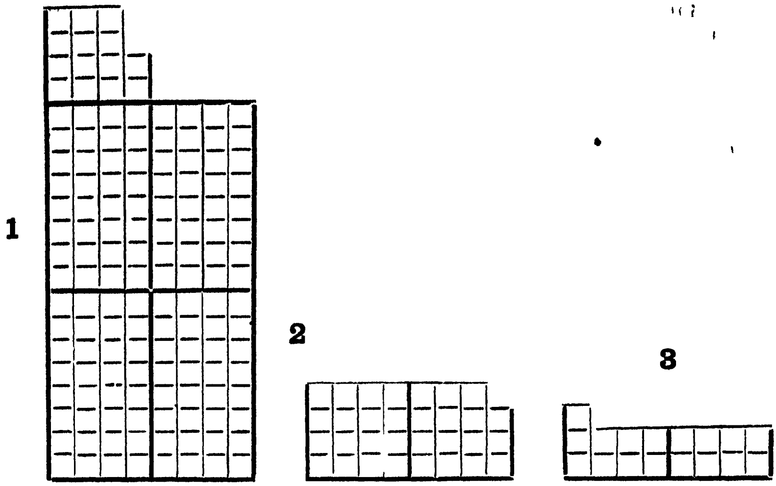
THE DISEASE ON THE FRUITS.

It is well known that the cacao fruits become diseased and that the fungus may spread from the stem to the fruit, or from the fruits to other fruits or to stems. In most cases the presence of a large number of diseased cacao fruits can be associated with the prevalence of the fungus in the stem. The disease on the fruits is usually more obvious than when on the stems ; the pods become dark-brown or black, and the abundance of such fruits appeals most strongly to the planter. Furthermore, the fungus grows very rapidly on the fruits, and if proper attention is not given to them, a serious condition may arise. There are two ways by means of which the spread of disease by the fruits may be controlled.

The first is by collecting the young and old diseased pods at frequent intervals of every few weeks, in and out of the crop time. If the diseased pods are large and contain seeds, they can be shelled and the seed collected, but in all cases the diseased fruit walls should be either burned or buried with lime on the spot.

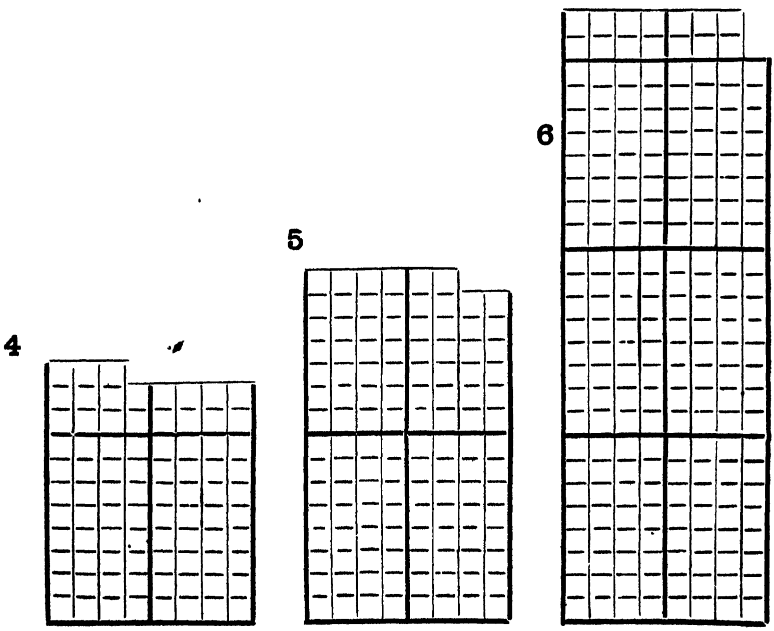
The second means is the adoption of spraying. The pods can be sprayed by a mixture of copper sulphate (6 lb.), lime (4 lb.), and water (45 gallons). The pods should be lightly sprayed on successive occasions during moderately dry weather. Experience has taught us that the best results are obtained by spraying the young pods just after they have set. In the Peradeniya district, where the months for flower production are April and May, the young pods set in August, and it is during the latter month that spraying can best be carried out. Several kinds of sprayers can be used, but on most cacao estates it is almost essential that the sprayer shall be one which can be carried on the back of a coolie. The jet used should be as fine as possible, as otherwise there is considerable waste of the mixture. It is only necessary to spray the fruits lightly; the mixture which goes on to the leaves or stem is practically wasted.

THE DECLINE IN PERCENTAGE OF FUNGUS FRUITS.



1902	1903	1904
85·5 per cent.	7·7 per cent.	4·3 per cent.

THE INCREASE IN CROP.



1902	1903	1904
0·88 cwt.	1·18 cwt.	2·07 cwt.
Per acre.	Per acre.	Per acre.

RESULTS OBTAINED.

These, then, are some of the methods by means of which, it is asserted, the fungus on the cacao trees can be kept under control. The practical man necessarily requires an authentic case of the results which have been obtained, and though his neighbours can probably supply him with sufficient facts and arguments in favour of the treatment here advocated, a result is here quoted because it can be vouched for.

The accompanying illustration will help to make the case in point more striking. In 1902 the cacao was very badly diseased, as many as 96 per cent. of the trees and 14 to 62 per cent. of the pods collected being attacked by the fungus. The curative methods herein described were commenced in May 1902, and within six months an improvement was obvious. In 1902, the percentage number of fungus pods was 35; in 1903, this was reduced to 7 per cent, and in 1904 to 4 per cent., by an expenditure which was more than covered by the value of the increased crop. In 1902, the crop was only 0·83 cwt. per acre; in 1903 it rose with a decrease in the disease to 1·18 cwt., and in 1904 to over 2 cwt. per acre.

It is therefore proved that when the fungus has developed almost to its maximum it can still be attacked with a prospect of being reduced to a minimum within three years, on an expenditure which is made good within that period.

PARA RUBBER IN CEYLON.

The cultivation of Para rubber (*Hevea brasiliensis*) has spread very rapidly during the past few years in Ceylon, the Straits, and other parts of the tropical world. A Circular (Vol. III, No. 6), which has recently been issued by the Royal Botanic Gardens, Ceylon, gives an account of the conditions under which the cultivation of this tree has developed in the island. The following brief abstract of this circular is likely to be of interest:—

In 1876 some hundreds of young plants of *Hevea brasiliensis* were received from Kew at the Royal Botanic Gardens, Peradeniya.

It is nearly thirty years ago since the plants arrived, and when one reviews the past it is surprising to find how cautiously the planting community regarded the latest addition to the series of tropical products in the island. The facilities which now obtain in planting districts are such that the extension of Para rubber cultivation in Ceylon will probably take place at a very rapid rate in the near future, and it is therefore of interest to record the state of affairs at the close of the twenty-ninth year from the introduction of the original plants.

In his report for 1904, the Director of the Royal Botanic Gardens says:—

The planting of Para rubber has been vigorously pushed on during the year, and the estate census of June 1904, in Ferguson's *Directory*, shows that there were then approximately 10,084 acres in rubber alone and 26,201 acres of other products, chiefly tea, interplanted with rubber. In perhaps most cases the interplanting is so close that the rubber will ultimately choke out the intercrops. It will probably not be far from the mark to regard the area of rubber in Ceylon as about 25,000 acres. The export has increased, being 681 cwt. for 1904, against 889 cwt. in 1903. The prices obtained have been extraordinarily high, reaching on two occasions as high as 6*s*. 1*d*. per lb. for biscuits.

At the present time it can be asserted that Para rubber will grow and yield latex up to an elevation of 1,500 feet and even 2,000 feet in the southern and central provinces, and possibly at a higher elevation on the Uva side. Most people recognize that the cultivation of Para rubber above 2,000 feet in any province except Uva is of an experimental character.

The cultivation of these trees at Peradeniya at an elevation of 1,500 feet was regarded in the old days as distinctly experimental, but the growth obtained is now acknowledged by all to be excellent. The Para rubber trees at Peradeniya were planted in the south garden near the river banks, but above flood-level. They were planted 10 feet apart, probably in 1876, and the following were the dimensions of all the trees in June 1905 :—

No. of tree.	Length of trunk.		Circumference in inches, 3 feet from base.
	feet	inches.	
1	51	7	44
2	89	6	82
3	73	3	52
4	82	7	59
5	84	2	59
6	55	4	49
7	78	7	58
8	79	3	56
9	89	5	81
10	76	2	50
11	74	3	43

Such growth has been a matter of surprise to many persons and has led to the suggestion that, given good physical conditions, Para rubber can be cultivated in moderately chemically poor soils if planted a sufficient distance apart.

CLIMATIC REQUIREMENTS

In its native home Para rubber thrives well along the banks of the Amazon, where the soils are more or less alluvial and moderately damp.

Rainfall.—The question as to the most suitable rainfall for the successful cultivation of this product is of importance. There is a rainfall of 80 to 120 inches in its native home, and it has been proved that this average annual rainfall is equally suitable for rubber in many parts of this island. The cultivation in dry areas with the help of irrigation and in districts with 100 to 200 inches of rainfall is promising, and it is more than likely that a wide variation in annual rainfall will be found suitable for this product.

Temperature.—In its native home Para rubber thrives best in a mean temperature of 75° F. to 81° F. There are many districts in Ceylon which have a somewhat similar temperature to this. Given the required temperature, the rainfall or moisture may be altered by means of irrigation.

CHEMISTRY OF PARA RUBBER.

The section of this circular relating to the chemistry of Para rubber is reproduced *in extenso* :—

Samples of fresh and green leaves, stalks and wood, have been analysed, and though in each case a considerable variation was found, the results are here given for the information of interested correspondents.

Fresh Leaves and Stalks.—These were taken from a twenty-five-year-old tree at Henaratgoda. The analyses show a wide variation, but the following figures indicate the relative proportion of the ingredients in the fresh state:—

Ten thousand pounds of fresh leaves (as received) contain 141 lb. of mineral matter, which is composed of 52 lb. of potash, 18 lb. of phosphoric acid, 17 lb. of magnesia, 15 lb. of lime, and other ingredients made up the total. The same quantity of fresh leaves also contain 103 lb. of nitrogen.

The weight of the foliage which is obtainable from trees of known age and in different districts remain to be determined.

Decayed fallen Leaves and Stalks.—If the analyses of the fallen leaves and stalks be now taken, one can see that the mineral food and nitrogen are largely returned to the soil. The sample was taken from the large quantity of leaves which were lying on the surface of the ground in the Henaratgoda Garden. It had been raining the night previous to the gathering of the leaves, so that the latter contained a large percentage of moisture. As some of the leaves had begun to decay, the results are therefore not strictly comparable with

the figures for the fresh, green leaves. Although the analyses show great variation, there can be no doubt that the mineral food in the fresh leaves is largely returned to the soil.

Composition of fallen Leaves.—Ten thousand pounds of fallen leaves, containing 60 per cent. of moisture, possess 163 lb. of mineral matter and 77 lb. of nitrogen. Such a quantity of leaves contain 58 lb. of lime, 36 lb. of magnesia, 22 lb. of potash, and 12 lb. of phosphoric acid. Prior to the annual leaf fall a series of chemical changes is taking place whereby varying quantities of different ingredients are re-absorbed into the stem. Such phenomena are mainly responsible for the difference in the composition of the fresh and fallen leaves.

Composition of the Leaf-stalks.—Ten thousand pounds of leaf-stalks contain, according to some analyses, 127 lb. of mineral matter and 84 lb. of nitrogen. The potash in 10,000 lb. of stalks often weighs 26 lb., the lime 32 lb., the magnesia 12 lb., and the phosphoric acid 6 lb.

Composition of Wood and Branches.—The analyses of the wood and smaller branches show the food material, which is taken from the soil and retained under ordinary circumstances. (The wood as received contained 50 per cent. of moisture.)

The following figures are calculated on 10,000 lb. of the original material. The total mineral food amounted to 156 lb., the lime to 40 lb., the magnesia to 8 lb., the potash to 15 lb., the phosphoric acid to 9 lb., and the nitrogen to 29 lb.

The twigs have a similar analysis, the total mineral food in 10,000 lb. being 105 lb., the lime 33 lb., the magnesia 7 lb., potash 12 lb., phosphoric acid 4 lb., and the nitrogen 24 lb.

The following table will show, at a glance, the varying proportions of the important ingredients in various parts of the rubber tree:—

ANALYSIS OF RUBBER TREE, DRIED AT 100° C.

	Fresh leaves.	Decayed fallen leaves.	Fallen stalks.	Wood.	Twigs.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Water	70·00	60·00	60·00	60·00	50·00
Ash	4·69	4·08	3·18	3·12	2·62
Lime	0·51	1·40	0·80	0·80	0·83
Magnesia ..	0·56	0·89	0·30	0·15	0·17
Potash	1·72	0·54	0·64	0·30	0·28
Phosphoric acid	0·60	0·30	0·15	0·18	0·09
Nitrogen ...	3·44	1·92	0·84	0·59	0·62

MANURING PARA RUBBER.

It will be seen from what has already been said, that, given a fair supply of plant food, the Para rubber will grow and yield latex, providing desirable physical conditions exist. The Para rubber tree does not necessarily require a soil with a high percentage of organic matter and mineral food as was imagined by early investigators, although rubber grows well on such soils. Under cultivation the trees can be made to grow well on light, sandy loams at the proper elevation in districts having the necessary rainfall and temperature. So, given a fair balance of plant food, the Para rubber tree will flourish, as there is not much drain on the soil by food material being permanently removed—only the mineral matter and nitrogen taken away in the rubber. Although the loss is small, yet it should be taken into consideration after a number of years, and an attempt made to replace the mineral matter and nitrogen. We do not at present advance any opinion as to the effect of manuring on the yield of latex in old trees, nor can we yet refer to any reliable results which would allow us to put forward even a hypothesis. We are at present of the opinion that manuring at the young stage would help on the young plants and thus prove to be beneficial, giving rise to good wood and large supplies of leafy material. We would strongly recommend that the fallen leaves be buried with lime or basic slag in trenches, or round the trees at a distance of 4 to 6 feet from the trunks; this basic dressing will promote nitrification and give rise to the more rapid decomposition of the organic matter. Light forking is recommended to break up the hard surface of the soil and so aerate and allow penetration of the rain and air.

BUD-ROT DISEASE OF COCOA-NUT PALM.

This disease is now causing considerable anxiety all over the West Indies. for evidence seems to point to its being widely distributed. It appears to be well known in Jamaica, British Honduras, and Cuba, and has lately been reported in Trinidad and British Guiana. There can be no doubt that the disease is spreading, and unless combined and energetic action is taken to stamp it out, the cocoa-nut industry of the West Indies must materially suffer.

With a view of placing all the literature available before those interested, the following information is published.

Probably the earliest notice of the occurrence of bud-rot under the name of 'Fever' in cocoa-nuts in this part of the world is published in the *Bulletin of the Botanical Department*, Jamaica, 1891, No. 23, in which the Hon. W. Fawcett, B.Sc., F.L.S., Director of Public Gardens and Plantations, reports that the cocoa-nut palms at Montego Bay, Jamaica, were dying of a disease which seemed to be very active in its destructive effects.

The next mention of the disease occurs in *Kew Bulletin*, 1893, p. 41, where it is reported as occurring in British Honduras. There it is described as 'fever,' and it is suggested that it may be allied to, if not identical with, the disease reported by the Hon. William Russell to Kew in 1875-6 as doing considerable damage in Demerara.

The appearance and progress of the disease, as described in British Guiana, correspond exactly with those in other countries. It is probable, therefore, that what is now known as the bud-rot disease has been present among cocoa-nuts in this part of the world for nearly thirty years, but it has only lately come into great prominence.

Between 1876 and 1891 the effects of the disease were probably not of a serious character, as until the American occupation of Cuba, when the cocoa-nut palms of that island were found to be dying in large numbers of a mysterious disease, general interest was not taken in it. The trees when attacked show, as a first sign, yellowing and drooping of the outer leaves, then a gradual dropping of the nuts, when present, and afterwards the destruction of the terminal bud, ending in the death of the plant. The roots and stem of the palm may be perfectly healthy while the terminal bud is in a high state of putrefaction.

In 1901, Mr. August Busck was sent by the U. S. Department of Agriculture to investigate the disease in Cuba and subsequently reported that he thought the primary cause of the disease of the palm was a fungus, *Pestalozzia palmarum*, Cooke, but the foul smell of the diseased parts seemed to indicate some bacteriological influence, when the palm is already weakened by fungus. He suggested that insects might assist in the spread of the disease and pointed out that probably the spores may be carried by them for a considerable

distance and thus cause the spread of the disease over a large area.

Mr. F. S. Earle (now Director of Agriculture in Cuba), when he was investigating the disease in Jamaica in 1902, stated that it was from the first a bacterial rot. The organism develops in the sweet coatings of the young protected organs and finally it reaches the 'cabbage' or central growing point, which it soon reduces to an offensive smelling mass (see *West Indian Bulletin*, Vol. IV, p. 4).

A more recent account of the disease, observed in Cuba by Dr. Erwin Smith, of the U. S. Department of Agriculture, was published in *Science*. Dr. Smith seems also to be convinced that the disease is primarily due to the action of bacteria and states that, although fungi can be found on the parts longest diseased, the advancing margin of the decay was occupied only by bacteria, of which there appear to be several sorts.

Latterly, bud-rot has forced itself into prominence at Trinidad, where on one plantation it is reported that 2,000 trees out of a plantation of 25,000 have been lost within the last six months. The Government and the Agricultural Society are in correspondence with the Imperial Department of Agriculture on the subject. A very complete set of specimens has lately been received from Trinidad through Mr. J. H. Hart, F.L.S., Superintendent of the Royal Botanic Gardens, and the Mycologist is now closely occupied in examining the material in the hope of being able to add something of interest in connexion with the spread and treatment of the disease. Correspondence has also been received in reference to the presence of bud-rot at British Guiana. An extract from a report on the subject by Professor Harrison is also published.

With regard to treatment, it is probable that no remedial measures are likely to be effective with palms already attacked. Efforts should therefore be directed to preventing the further spread of the disease by cutting down all diseased palms and destroying by fire or burying with lime the diseased portions.

Experiments have been carried on by Mr. Cradwick in Jamaica, under the direction of the Hon. W. Fawcett, with the object of finding a remedy for this disease. It is found that spraying the trees with Bordeaux mixture, when they show first signs of disease, has been effectual, and it is hoped, in Jamaica at all events, that with the use of Bordeaux mixture the disease may be kept in hand. Nevertheless, it must be pointed out that only the most energetic and combined efforts can eradicate a disease of this virulent character and that a process of 'stamping out' must be relied upon as the principal method of dealing with it. It is interesting to note that it is claimed by some planters in Jamaica that a certain green-skinned variety of cocoa-nut is less liable to the disease than the reddish and yellowish kinds. If this statement be confirmed, it would be a factor of some importance, as it would then make it possible in the case of new plantations to select a race of cocoa-nut palms which might be resistant to this disease.

The following is a report, addressed to the Colonial Secretary, on the cocoa-nut disease at Montego Bay, Jamaica, by the Hon. W. Fawcett, B.Sc., F.L.S., reprinted from the *Bulletin of the Botanical Department*, Jamaica (No. 23), 1891 :—

I have the honour to report that I have visited Montego Bay to examine into the death on a large scale of cocoa-nut palms in that neighbourhood.

The first intimation I received on the subject was an extract from the report of Mr. J. W. Gruber, Collector of Taxes, forwarded to me by you. At a later date, the Doctors McCatty favoured me with some observations that they had made.

I passed through the extensive plantation of Mr. Levy on the east of Montego Bay, and had the opportunity of hearing his remarks on the commencement and progress of the disease. The Rev. F. H. Sharpe, Rector of Montego Bay, showed me the devastation that had taken place among the cocoa-nut palms in the churchyard in the town.

I discussed the subject with the Doctors McCatty, Messrs. Gruber, George Robertson, Rerrie, Facey, and others.

Mr. Doull, the manager of Catherine Hall estate, on the west of the town, afforded me every assistance at the cocoa-nut plantation on the estate. Dr. Sinclair was also most kind and helpful.

Several trees were cut down and the roots, stem, leaves, and 'cabbages' examined. There was no evidence whatever of attacks by a beetle, there were some small larvae, some wood lice, earwigs, ants of several species, and other insects on the affected parts, but they were evidently only preying on the diseased juices, and were not the cause of the disease.

The roots were quite sound, and the stem appeared to be unaffected. Both stem and leaves were of normal size, and there was no indication of a gradual dwindling of vitality due to lack of proper nourishment extending over a long period. The disease, whatever it might be, seemed to be quick in destruction.

The youngest parts were those affected. The leaves and flowers in the bud were sometimes able, though affected, to withstand the disease so far as to open out, and some leaves and nuts attained almost their full development before the tree succumbed. In the case of tall trees, the first indication of the disease was the dropping of the young fruit. It was stated that the disease in this condition had been checked by setting fire to the fibrous material at the base of the leaves, which process burnt all the leaves; new fronds, however, developed, and the tree was, at any rate for the time, saved. The application of salt to the 'cabbage' had also, it was alleged, been successful. If the terminal bud in the 'cabbage' is affected, the tree is doomed.

In almost all the trees examined, the sour smell of a putrefactive fermentation was very noticeable, and I am of the opinion that the disease is due to an organized ferment

which is able to attack the very tender tissues of the youngest parts, even outside the terminal bud. If this ferment can be destroyed by fire or other means before it reaches the terminal bud in the heart of the 'cabbage,' the tree may be saved.

Any remedy should therefore be applied on the very first signs of disease. If delayed too long until the terminal bud is diseased, the tree cannot be saved.

Although to fire the fibre at the base of the leaves is easy of application, it is not safe near buildings, and by the destruction of the leaves, the production of fruit is for a long time retarded, with consequent loss.

I would recommend that those who do not care to apply fire should drench the 'cabbage' with a solution of sulphate of iron in water in the proportion of 2 ℔. of sulphate to 1 gallon of water. A solution of sulphate of copper might also be tried in the proportion of 5 parts to 100 of water, and a solution of boracic acid in the proportion of 4 parts to 100 of water.

All diseased trees which cannot be saved should be cut down and burnt, to prevent infection.

In order to give the tree every chance of recovery the soil might be scraped away from the roots, and the ashes of the burnt trees applied together with some manure.

It may be said that these remedial experiments are costly, but, on the other hand, the annual value of each tree is stated to be at least 4s.

The *Kew Bulletin*, 1893, pp. 41-3, contains information (compiled by Mr. Walter H. Blandford, M.A., F.E.S.) respecting 'Fever' in British Honduras—probably identical with bud-rot. From this paper the following extract is taken :—

The cocoa-nut palms of Honduras appear also to suffer from disease, and disease of an obscure kind not due to insects. It is known as 'fever,' and at present no accurate account has been given of its symptoms, nor of its prevalence, so that it cannot yet be accepted as a cause of the weevils' increase, but it must be taken merely as a hypothesis to be inquired into. From the little known about it, it appears to be allied to one or other of the diseases (if, indeed, they are not the same) observed in Demerara in 1875-6, and in Montego Bay, Jamaica, in 1891.

Attention has been called to it in Honduras in a recent communication by Mr. Seay to the Colonial Office, of which the writer has seen only an extract. According to Mr. Hunter, 50 to 80 per cent. of the trees attacked by the weevil show signs of the disease at the top first. This may be merely a misinterpretation of the early signs of injury due to the weevil grubs before they have been noticed in the trunk, but the statement is of importance and should be confirmed or refuted. In his evidence Mr. Buber says he 'has a small spot on the sea-side in Serango Bight (very swampy). He there noticed that the trees died off very rapidly, although of various ages, from seven to ten years. He does not know the cause of death; some

trees on better land close by were not affected.' Mr. Schofield states that his plantation was apparently healthy on December 24. No tree or plant showed any signs of sickness. The hands went away for the Christmas holidays, and its condition was not observed during the next few days. On January 7, he discovered some fifteen trees more or less affected, some had actually fallen over, others had their fronds broken and trailing on the ground, while the rest from their yellow and drooping appearance showed plainly that they also were diseased. Commenting on this, he says 'it seems generally thought that it (the weevil) will not attack a plant unless the plant is in an unhealthy condition. How, then, is its presence to be accounted for in trees that only two weeks ago were perfectly healthy?'

As it is out of the question to suppose that weevil grubs developed from eggs laid after December 24 so as to cause such serious mischief, it is clear that the attack must have started some time before, and that its early stages were overlooked. The fact that no disease was noticed does not go for anything, unless special and thorough examination was made of the health of the trees afterwards found to be so attacked, a very different thing from mere non-observance of unsuspected mischief.

The accounts of the disease in Demerara are not of much assistance, because very little light was thrown on the cause. It has been described by the Hon. William Russel, who, in investigating it, was careful to distinguish between it and the work of different species of insects. He says of it that 'healthy, fine trees in full bearing commence to fail in a few weeks; all the leaves fall down, and the centre falls off. No beetle or worm is to be found; the disease seems more like what is known as plantain disease.' In a pamphlet published at Georgetown and not generally accessible, he gives the following account: 'My first dissection of a tree diseased from blight led me to suppose that the cause of the disease was the attack of the weevil in question [presumably the palm weevil, though not mentioned by name]. The part of the stem immediately under the cabbage portion was completely riddled by this insect, and hundreds of grubs, in all stages of development, were found. . . . . On dissecting the top of the tree, all the fruit germs were found quite rotten (putrid fermentation), and gave a most offensive smell, and at the point where the last frond or central spike divides from the lower fronds, the state of putrefaction was fearful. Fortunately, I decided upon trying another tree. This time the stem was perfectly sound, and without a speck; but on dissecting upwards, and carefully removing each frond and its integuments, the outer part was found to be more or less tainted, and the fruit-stalk from which the fruit had fallen was quite offensive. As the top of the tree was approached, the fruit germs became more and more rotten; still, on the integuments of each frond being removed, the "cabbage" in the centre was quite sound, so that I could eat the centre to within 6 inches of the diseased point, which, when reached, was quite as putrid as my first specimen. The crimped form of the bottom of this central spire left no doubt on my mind that the

seat of the disease was at that spot, and that there had been abundance of vitality in the lower part of the tree to send forth the central shoot until the parts immediately in contact with the putrid matter were poisoned by it. A careful examination was made of this and various other subjects without finding a trace of an insect, even with the aid of a powerful magnifier, and afterwards under the microscope. One small beetle was found on one subject which is before you, and was named by my friend, Dr. Whitlock, as *Papalus tridens*. . . . Seeing that only one specimen of this diminutive beetle was found in my many investigations, I can scarcely believe that the disease can be attributed to it.' What insect is meant is not clear. The generic name is obviously a misprint for *Passalus*, but *Passalus* (Eriocnemis) *tridens*, Wied., is a native of Malacca, etc. The *Passali* lay their eggs in decayed wood, and are harmless. Specimens of the diseased trees, preserved and sent to Kew, were carefully examined by Dr. M. C. Cooke for injurious fungi. His search resulted in the description of several new species, but he could not find one that appeared to be the true cause of the disease. Since 1876 the study of disease-producing fungi has made great strides, and that of bacteria has been almost entirely created; and it is possible that a similar thorough examination would now yield different results. The treatment then adopted was excision of the diseased parts, washing with clean water, and dressing with caustic lime. No results are given. Mr. Russel was positive that the disease was infectious and spread to windward, and was most virulent where the trees were planted close, 3 rods each way.

These facts should be studied by planters in British Honduras; for in the event of disease being proved to occur, suitable steps must be taken to check its increase as well as that of the weevil. But whether the latter is encouraged by the presence of diseased trees or not, no relaxation of the measures taken against it should be permitted.

Bulletin No. 38 of the Division of Entomology of the U. S. Department of Agriculture contains a report of an investigation of diseased cocoa-nut palms in Cuba, by Mr. August Busck. The following extracts from this report are of interest:—

In August 1901, I was instructed to proceed to Habana, Cuba, and report to the Military Governor there, in order to investigate a disease, which threatened the cocoa-nut industry in the province of Santiago.

The country around Baracoa is the only remaining cocoa-nut region of importance in Cuba, and the industry is the main support of that part of the island, from which large shipments of great value are annually exported to the United States.

There were no diseased palms in the immediate neighbourhood of Baracoa, but going out some 10 miles east along the coast, yellow, dropping tops and naked trunks began to appear, and still farther out around Mata and neighbouring towns the disease reached its highest development. Here large areas were attacked, and already from 10 to nearly 100 per cent. of the trees were lost. Serious damage was quite evident, and

the lamentations of the natives and their anxious inquiries as to how to save their sole property were most natural.

The first outward indication that a palm is attacked is the falling of the young fruit; shortly afterwards the larger nuts drop and the leaves assume a pale-yellowish colour.

Within a month all the large lower leaves droop and fall, leaving the pale, sickly tops, which at the first heavy wind blow over, and then only the naked trunks stand as ghastly tombstones where a few months before stood graceful, valuable palms. Palms of all ages are subject to this disease, though it seems more prevalent among the older plants.

On felling a palm and examining it, it is apparent that the trouble is not found in the root or main part of the small trunk. From the root upward to within a few inches from the top, the trunk may be fresh and sound with practically no insect of any kind and with no fungus mycelium. Just below the top and in between the bases of the leaves were found in nearly all of the 300 odd palms in different stages of disease, which were cut down during my investigation, the galleries of scolytids or ambrosia beetles (*Xyleborus* spp.), rarely, however, in such numbers as to arouse suspicion of the beetles being the cause of the death of the palms.

In and around these holes, and perforating the entire upper part of the trunk for 2 to 10 inches downward, was found the mycelium of a fungus, the fruiting bodies of which came forth as small, white spots on the under sides of the leaves and which might easily, on hasty examination, be confounded with *Aspidiotus* scales which were often found there.

This parasitic fungus has been identified by Mrs. F. W. Patterson, Mycologist, and Mr. A. F. Woods, Pathologist, of the Department of Agriculture, as *Pestalozzia palmarum*, Cooke. They inform me that though they have no record of the particular damage, 'it is extremely probable that this fungus is the cause of the diseased condition of the trees,' as they have records of similar causes in other trees.

Breaking off the lower leaves and cutting open the centre of the green growing part, the heart of the palm is found to be one putrid, offensive-smelling mass, filled with maggots of various scavenger flies. By examining palms in various stages of sickness, it was found that the putrefaction began within the sheet around the young, still-unfolded flower-stalks and gradually worked downward to the centre of the plant, and while the primary cause of the death of the palm undoubtedly is the fungus, the nature and foul smell of the diseased parts seemed to indicate some bacteriological influence, when the palm is already weakened by the fungus and doomed to die.

In from one to three months after first attack full destruction takes place, and the trunk stands naked, and though it is still fresh and apparently sound, it soon disintegrates through the work of termites or white ants and other insects.

The fatal nature of the disease precludes a remedy for trees already infected and leaves only the prevention of the spread of the disease as the object for man's intervention.

As the most natural means of preventing the spread of the disease, the cutting down and burning up of the diseased palms suggests itself, and Mr. A. F. Woods agrees that this is one of the best ways of combating it. In a small and necessarily incomplete way I satisfied myself of the practical results of this preventive. Shortly after my arrival I observed one large grove with only two isolated dying palms. These I had cut down at once and removed the infested parts to my headquarters for examination. During my entire stay no more palms in that grove showed signs of disease, although in other tracts with sick palms left standing new cases of infestation were observed in numbers every week.

The procedure of felling and burning many palms may seem too enormous an undertaking, but, considering the interests at stake, it is a small matter and comparatively easy of execution.

Without such drastic measures the present conditions and the rapid spreading of the disease certainly foreshadow total destruction of the cocoa-nut industry, a very serious matter for the population of that part of the island of Cuba.

It is not necessary to burn the entire trunk, which would involve extra labour, but only the top with a couple of feet of the upper end of the trunk.

But it is necessary to have united action in order to make the remedy of any real value, as it is evidently futile for the proprietor of one estate to eradicate the disease within its limits, if the owners of neighbouring estates omit the precautions and allow the disease to multiply and send its spores abroad to the others. I therefore suggest local legislation, which would make it compulsory on every owner to cut down palms as soon as they show infection, and have the diseased parts burned; and, furthermore, that some trustworthy, intelligent man be constituted inspector with the duty to inspect weekly the entire region and with power to have cut down at once and burned at owner's expense any sick palm found omitted.

Such action, together with advice to plant new cocoa-nut palms, will, I fully believe, save the greater part of this important industry, which otherwise seems doomed to annihilation.

Of the palm weevil, *Rhynchophorus palmarum*, which before my trip was suspected as being the possible cause, not one was found.

As in a measure supplementary to the report, from which extracts are given above, of the investigation conducted by Mr. August Busck on diseased cocoa-nut palms in Cuba, due to the fungus *Pestalozzia palmarum*, Cooke, but supposed to have been caused by the palm weevil, a paper was prepared by Mr. F. H. Chittenden, Assistant Entomologist to the U. S. Department of Agriculture, on the insects attacking the cocoa-nut palm. A few points mentioned in this paper are

of interest, as they relate to the so-called 'sickness' or 'fever' of these palms.

In a paragraph discussing whether insects attack healthy or only 'sickly' trees, he mentions that 'the belief is quite prevalent in British Honduras that the palm weevil is the chief cause of the great damage to cocoa-nut trees in that colony.' Continuing, he publishes the opinions of Mr. E. J. F. Campbell, Curator of the Botanic Station, Belize, Honduras, in which it is pointed out 'that the disease locally known as "fever," presumably due to the fungus *Pestalozzia palmarum*, or a similar species, is the sole forerunner of the trouble. He supposes it to be conveyed from unhealthy trees growing in unsuitable ground.' On this head Mr. Campbell expresses himself substantially as follows:—

'From my own observation I am of the opinion that cocoa-nut trees are never attacked by weevils unless the plant is more or less in a sickly condition—a fever of some kind. This fever may originate from different circumstances, such as sudden cold weather, excessive wet, causing water to lie around and affect the roots, the want of good drainage, inferior soil, sudden exposure of the stem to the direct rays of the sun or other conditions due to planters neglecting to clean their trees for months or years.'

He is convinced that 'no fly, bug, or weevil' will attack a perfectly healthy cocoa-nut tree that receives proper attention by its owner.

The remedial treatment suggested by Mr. Chittenden is the same as that recommended elsewhere, viz., cutting down diseased trees, sawing off and burning all the infected portions. He also recommends that considerable care should be taken in the choice of sites for new plantations, undue proximity to what is known as 'cohoon' ridge being avoided. Thorough drainage and wide planting are also advised; and the trees should be left as far as possible in a natural state. He thinks, however, that insects are the cause of the spread of the disease, which attacks palms grown both in British Honduras and in the West Indies. He also sympathizes with the planter who is doing his best to keep the disease in check, while his neighbours, who also grow palms, do not take any pains to employ remedies against the disease. Finally, he states that 3 or 4 miles is no distance for the insects to fly in search of a sickly tree or one that is beginning to bear fruit, because then the bark is soft and the sun will make cracks through which sap oozes out in quantities, which is liked by all these pests. These cracks would also afford an excellent entrance for any disease that is being carried by any of these insects.

A report by Mr. F. S. Earle (now Director of Agriculture in Cuba) on some diseases of economic plants in Jamaica, reproduced in the *West Indian Bulletin*, Vol. IV, pp. 1-9, from the *Journal of the New York Botanical Garden*, Vol. IV, pp. 1-10, contains the following notes on the cocoa-nut bud disease:—

Outbreaks of a serious disease of cocoa-nut trees have occurred in Jamaica at various times. Some years ago the

groves in the neighborhood of Montego Bay were badly injured by it, and the industry was completely destroyed on the Grand Cayman Island, probably by the same trouble. At present it is attracting but little attention, although numerous cases of it exist widely scattered over the western end of the island, a few being observed as far to the eastward as Port Antonio. It was not observed to the east of a line between Port Antonio and Kingston. One of the first symptoms of the disease is the dropping of immature nuts. In some cases the lower clusters hang on and reach maturity, but usually all fall off. The leaves droop a little, and become somewhat yellow. Often those that are just unfolding are seen to be distorted and blackened on the edges. The young flower-buds, still enveloped in the spathe, rot, and finally the central leaf-bud rots and the entire top falls away. Such trees are often pointed out by the planters as having been struck by lightning. Others attribute the death of the tree to a large borer said to work from the trunk up into the bud. In the numerous cases examined death was not due to either of these causes. The head of the tree was in all cases invaded by what seems to be a bacterial rot. The organism develops in the sweet, slimy coating found on all the young protected organs. It eats into the sheathing bases of the petioles and attacks the flowering sheaths. As the spathe grows, the surface becomes cracked, and the disease reaches the soft flower-buds through these cracks. Finally, it reaches the 'cabbage' or central growing point which it soon reduces to a stinking, rotten mass. The top now falls away, sometimes leaving a circle of the lower leaves that had matured before the tree was attacked. These persist for a time, but of course finally die also, as the tree has no power of branching or of producing a new growing-point. The means by which the contagion is conveyed from tree to tree could not be determined, nor could any estimate be formed of the time elapsing between the infection and the death of the tree. Numerous cultures were secured, and the study of the disease will be continued.

At Port Antonio the petioles and midribs of the leaves of some of the diseased trees were found to be invaded by a parasite that caused the browning and death of the tissues. This petiole disease was found on some trees that did not as yet show signs of the bud trouble. Whether or not the two troubles are caused by the same organism can only be determined by the further study of the cultures that were secured.

From our present imperfect knowledge of this disease it is impossible to suggest a remedy. Remedial measures or rather successful preventive measures would probably depend on the method by which the disease is conveyed from tree to tree. This can only be determined by careful and prolonged field study. The importance of the industry involved would fully justify the expenditure and effort necessary to obtain a complete understanding of this disease. The necessity for the destruction of the contagion by the prompt cutting and

burning of all infected trees is shown by the marked tendency of the disease to spread from each centre of infection.

It is claimed by some planters that a certain green-skinned variety of cocoa-nut is less liable to this disease than the reddish and yellowish kinds. The facts observed seemed to support this view. If it is confirmed by further observations, it will be a factor of the greatest importance, as it would make possible the selecting of a resistant race of cocoa-nuts.

The following is reprinted from the *Bulletin of the Department of Agriculture*, Jamaica, March 1905, pp. 51-2, and contains a report on experiments that are being carried on in Jamaica with diseases of cocoa-nuts:—

The Director has examined from time to time all over the island reported cases of diseases of cocoa-nuts. In many instances the unhealthiness or death of trees was due simply to the unsuitable nature of the soil or climate. If the soil is a thick clay, or rocky, or very poor in plant food, or very dry, or liable to be saturated with standing water, the trees are never healthy, and when the conditions are more than usually unfavourable, they may succumb altogether. While in this unhealthy condition they are much more liable to the attacks of insect and fungus pests, and the immediate cause of death may be due to attacks which reach such vital parts as the terminal bud or the feeding roots.

But besides unhealthiness and death due to unfavourable conditions, there is a disease which attacks the flower parts and young nuts, sometimes spreading along the softer tissues, and at length reaching the terminal bud, causing the death of the tree.

Mr. Cradwick has been engaged at intervals during the last two years in applying various remedies suggested by me. These experiments are still in progress, but I may say that I find the most effectual remedy is to spray with Bordeaux mixture at intervals of six to nine months until there is no trace of disease. A spray pump is necessary, and even high trees can be sprayed by attaching a long hose to the pump, and sending a boy up with the nozzle, or even by tying it to the end of a long bamboo.

In Grand Cayman and in parts of Jamaica planters have not been successful in growing cocoa-nuts because the young plants die off just at the time of the first flowering. It is now hoped that, with the use of Bordeaux mixture, they will be able to grow them.

Bordeaux mixture is best made according to the following formula:—

Copper sulphate	6 lb.
Unslaked lime	4 lb.
Water	50 gallons.

It requires careful mixing, or the ingredients will not combine properly. Put 25 gallons of water into a barrel, tie up 6 lb. of copper sulphate in a piece of coarse sacking, and

hang this by a stick laid across the top of the barrel so as to be just beneath the surface of the water until it has slowly dissolved.

In another barrel slake 4 lb. of lime very slowly and carefully, at first only adding about a quart of water at a time, until a perfectly smooth paste free from grit is obtained, add water to make the whole 25 gallons and wait until cool. Now pour both together into a cask holding 50 gallons. The milk of lime should be thoroughly stirred before pouring, and finally the mixture should be well stirred for four or five minutes with a wooden paddle. If not perfect, the mixture is liable to injure the foliage, and in order to test this, put the blade of a penknife into the mixture and leave it for one or two minutes. If there is any deposit of copper on the blade showing a brownish colour, it is not safe to use it, and more lime must be added until the knife is not discoloured.

A paper prepared by Dr. Erwin Smith, U. S. Department of Agriculture, on the bud-rot of the cocoa-nut palm in the West Indies was published in *Science* and reproduced in the *Bulletin of the Department of Agriculture*, Jamaica, for June 1905. A reprint of this paper is here given:—

General attention was first called to this disease by the reports of army officers during the American occupation of Cuba. The cocoa-nut palms were said to be dying in large numbers of some mysterious disease which should be investigated. Mr. A. Busck was sent by the U. S. Department of Agriculture to eastern Cuba, and subsequently reported on the entomological aspects of the disease. Later, Mr. F. S. Earle reported the occurrence of a bacterial bud-rot of the cocoa-nut in Jamaica. The writer has since heard of its occurrence on the mainland in Central America, so that it may be assumed to occur all around the Caribbean. It was studied by the writer at Baracoa, Mata, and Yumuri in eastern Cuba in April 1904.

The disease has made decided advances since it was studied by Mr. Busck in 1901, especially at Mata, and, if it continues to spread as it has done during the past ten years, it will inevitably destroy the cocoa-nut industry of the island, and that, too, within the next ten or fifteen years. Already many of the planters are discouraged and are not setting any more trees, since it now attacks trees of all ages, including quite young ones and those on the hills as well as those close to the sea. The disease is frequently known as the 'fever,' and often one sees where the bases of the trunks have been scorched with an idea of preventing the development of the disease. The disease is not lodged in the roots, however, nor in the stem. These in all cases appear to be sound. The general symptoms are the yellowing and fall of the outer leaves, the shedding of the nuts, and some months later the death of the whole crown. The cause of this decline is not apparent until the tree is felled and the crown of leaves removed, including the wrappings of the strong terminal bud. The latter is then found to be the seat of the disease. This bud with its wrappings of young and tender leaves is found to be involved in the

vilest sort of a bacterial soft rot—not unlike that of a decaying cabbage or potato—but smelling much worse, the stench resembling that of a slaughter-house. This rot, invisible until the numerous outer leaf-base wrappings are removed, often involves a diameter of several inches of soft tissues and a length of 3 or 4 feet, including flower-buds and the whole of some of the soft, fleshy, white, undeveloped leaves covering the bud and forming the so-called 'cabbage' of the palm. The rot stops very promptly with the harder tissues of the palm stem immediately under the bud and does not attack any of the developed leaves. It is a disease of the undeveloped tissues. When the tree is felled and opened up, carrion flies and vultures are promptly attracted by the horrible smell. Fly larvae and various fungi were found in the parts most exposed to the air and longest diseased, but the advancing margin of the decay was occupied only by bacteria, of which there appeared to be several sorts. No yellow or green fluorescent bacteria were obtained from the rotten tissues. All were white organisms of the 'soft-rot' type, mostly plump, short rods with rounded ends but occasionally longer rods, all apparently gas producers. One of the commonest sorts formed round, dense, creamy, white, opalescent colonies on agar. Another formed thin, gray-white, irridescent colonies on agar. A terminal, spore-bearing, tetanus-like organism was also often abundant in the decayed tissues, even close to the advancing margin of the rot, and this is probably an anaërobe, as it was not obtained in any of the many cultures.

The picture of one diseased tree will answer for many. No fungi or insect injuries were found which could in the least account for the death of the tree. The disease is the result of bacterial rot of the terminal buds and its wrappings, including the flower-buds. The bacteria probably find their entrance through wounds of some sort, and their distribution is undoubtedly favoured by carrion creatures. The larva found deepest down in the rotting tissues was that of the common scavanger fly, *Hermetia illucens*, L. Occasionally the crown of a tree was found yellow from other causes, but if the youngest visible leaf (projecting 5 or 6 feet) was observed to be lopped over and wilting or shrivelled, the soft rot was sure to be found on cutting down the tree and removing the close-wrapped leaf-bases. No attempt has yet been made to produce the disease by pure cultures.

Diseased trees should be felled and the terminal bud burned or properly disinfected with sulphate of copper. Only the most energetic action is likely to avail.

The following is an extract from a preliminary report by Mr. J. H. Hart, F.L.S., on the bud-rot disease of cocoa-nuts in Trinidad, read before the Trinidad Agricultural Society, September 12, 1905:—

In accordance with instructions I proceeded on the 17th. instant to Le Retraite estate, Cedros, to make inquiries as to the state of a disease reported to exist among cocoa-nut plantations on the Gulf Coast.

Under the guidance of Mr. Greig, I examined the fields, witnessed the cutting down of a typically infected tree, and personally dissected and secured from it the necessary specimens for microscopical observation.

My observations lead me to conclude that the plantation itself affords distinct evidence that there has been for many years a succession of deaths among the trees on certain areas, which latter appear to have been replanted several times over. In my opinion this is strong evidence that the disease is not new, but has been present in more or less severity for years.

A primary microscopical examination shows bacteria in great quantity in the affected parts and especially in the heart, or growing portion of the tree. One of these, which is seen in the greatest number, is similar to the bacterium causing *tetanus* or lockjaw, i. e., drum-stick shaped. The tree examined was found to be infected from the ground upwards, and when the stem was cut through a ring of red discoloration was found lying between the woody exterior and the cellular interior parts of the stem. This discoloration became more prominent as it reached the growing-points and appears specially to infect the base of the leaf-stalks and the base of the embryo spathes enclosing the flowering organs. These eventually become quite rotten and putrid, the leaves fall and the tree gradually dies, the 'heart,' 'cabbage.' or bud becoming completely rotten.

In *Kew Bulletin*, 1893, p. 41, a disease called 'Cocoa-nut Fever' is discussed, and British Honduras, Jamaica, and Demerara are mentioned as places where it has been observed. The description given of this disease appears to leave little doubt as to its identity with that now being examined in Trinidad. As in Trinidad, this disease is reported to occur where no damage has been done by the palm beetle (*Rhyncophorus palmarum*).

In the meantime such experiments as suggest themselves for the purpose of throwing light upon the origin of the disease will be undertaken by the writer, and such may prove useful as preliminary steps to a more thorough investigation.

The following extract from a letter, dated September 14, 1905, from the Director of Science and Agriculture in British Guiana to the Government Secretary, shows that the bud-rot disease is prevalent in that colony:—

I have the honour to inform you that in July last, at the request of Mr. W. A Bond, of plantation Adventure, Essequebo, I visited his plantation to examine into the existence of a disease which he alleged was attacking and rapidly destroying many of his cocoa-nut palms. He had reported the existence of this to the Government Botanist in June 1904, but that officer considered it to be due to defects in cultivation.

Accompanied by Mr. Ward, I examined the palms at Mr. Bond's plantation, and found that the disease had worked great havoc among the cocoa-nut palms and that it is rapidly spreading. Mr. Bond stated that he had lost over 100 young bearing trees since Mr. Bartlett's visit in 1904.

Trees attacked by the disease show as first signs a yellowing of the outer leaves, which soon fall and hang down from the 'cabbage' of the attacked palms, and later are shed from it; the shedding of all the nuts, irrespective of their size and state of development, was rapidly followed by the death of the palm and the falling of the mass of the 'cabbage.'

Accompanied by Mr. Bond, I walked for some miles along the road in the direction of plantation Aurora and visited some small plantations. Here and there the palms were similarily diseased, and the disease was invariably following the course noticed at Adventure.

Being struck with the importance of checking the disease, if possible, I directed Messrs. English and Ward to follow up my examinations as far as plantation Aurora. They did so, felling several of the diseased trees and finding in all felled similar appearances. The terminal bud appeared to be the part attacked and was in every case in a state of rot. The rot appeared to spread from this gradually through the whole 'cabbage' of the palm. Many small beetles and larvae of flies, etc., were found in the decaying mass. Mr. Ward found that the disease is more or less prevalent in all the cocoa-nut cultivations between Adventure and Aurora.

In my mind there is little doubt that the disease is the same as, or similar to, the bud-rot disease of the cocoa-nut palm described as occurring in Cuba, but which now appears to be spreading in Trinidad and elsewhere.

In my opinion, if this is so, no remedial measures are likely to be effective with regard to palms already attacked. Efforts should be directed to preventing the further spread of the disease and this can best be done by felling every palm that shows any sign of attack. The upper 2 or 3 feet of the stem and the whole of the 'cabbage' ought to be destroyed at once by burning. If this is not feasible, these parts should be buried, the 'cabbage' being covered and surrounded by layers of lime.

The cocoa-nut plantations in Essequebo in which the disease has made its appearance are not situated on heavy clay soils, but on fairly light, rich loams, well suited for the growth of the palms.

In view of the importance of the ravages of the disease being, if feasible, checked, I have the honour to suggest that a copy of this letter may be sent to the Imperial Commissioner of Agriculture with a request that, if he considers it advisable, the services of the experts attached to his Department may be utilized in investigating it.

THE NAUDET PATENT PROCESS FOR EXTRACTING AND PURIFYING CANE JUICE.

An article on the Naudet process of sugar manufacture, by Mr. Robert Harvey, M.I.Mech.E., was published in the *West Indian Bulletin* (Vol. V, pp. 96-8). As this process has now been at work in the West Indies and definite results can be recorded, it may be useful to republish the following further article by Mr. Harvey, which appeared in recent issues of the *International Sugar Journal* :—

The important and interesting process, commonly known as the 'Naudet,' has been at work in the West Indies from about the beginning of the present year in the islands of Trinidad and Porto Rico.

PRINCIPLES OF THE PROCESS.

This process consists of treating the megass from the ordinary three-roller mill, only it is necessary to have a crusher in front of the rollers or a shredder immediately behind them, so as to have the cells of the cane laid thoroughly open, and thus give a good exposure to the hot juice which it comes in contact with when in the vessel of the diffusion battery.

The term 'diffusion,' as applied to this process, is not strictly correct. By diffusion we understand the action which goes on when two given liquids are separated by a membrane, the salt or sugar on the one side passing through to the liquid lying on the other side of the membrane; this action continues until equilibrium is established—that is, till the two liquids possess the same amount of salt or sucrose. This is what occurs in the extraction of sugar from beet root. In that case it is necessary to see that the roots are sliced up to a sufficiently fine degree so as to bring the membranes of all the cells into contact with the liquid. But with the sugar-cane the case is different. Under the action of the mill rollers and shredders all the cells are bruised or opened up, and the sugar which remains in the megass is retained there simply because it is of a spongy nature. This is shown by the fact that under the action of the rollers, the juice exudes from the pressed canes, and when the bed of megass is very thick one can with the hand squeeze out juice from this mass.

To reduce the thickness of the feed, or rather the discharge from the mills, double crushing was introduced—a great improvement on single crushing ; a still further improvement is triple crushing, and on some estates in Java there is quadruple crushing. All this is to overcome what is well known as reabsorption in the megass ; but no amount of crushing —it does not matter how many times—can ever extract all the juice from the cane because of this absorption—an essential evil in all mills.

Another evil in this repeated crushing of the megass is the fact, well known to all sugar makers, that with every additional crush after the first mill, impurities are imparted to the

juice from the rind of the cane, and in proportion to the number of times the megass is re-crushed the impurities are increased, so that the resulting juice is more difficult to work; furthermore, all these impurities have to be eliminated before good sugar can be made.

Now, the Naudet system overcomes these evils, and that in one operation; the juice coming from the first mill, where the crushing should only be from 60 per cent. to 65 per cent. of the juice in the cane, is comparatively pure. The remainder of the juice, which is still held in the megass, is then extracted without any pressure of rollers, but by the contact of the highly heated juice on the megass. The final washing or lixiviation is accomplished by a small proportion of water, which practically exhausts the megass of all sweets or sucrose.

CARONI ESTATE, TRINIDAD.

The first start was made on the Caroni sugar estate, Trinidad, in the month of February. The machinery on Caroni estate, previous to the new process, was double crushing. The first mill was the weakest one, the rollers being 36 inches in diameter by 78 inches long. The carrier was supplied from a steam railway going right alongside the same.

Crushing by the first mill gave an extraction of about 65 per cent. This juice, known as the normal juice, was pumped up to a tank sufficiently high to supply the diffusers by gravitation.

The megass from the first mill is elevated by one carrier to another, sufficiently high above the top of the diffusers to supply the same by gravitation. This elevated, longitudinal carrier, which is pretty near the top of the building, has shoots arranged with doors to supply any of the cells of the diffusion battery. The latter consists of ten cells, in two parallel lines of five on each side, each cell having a capacity of about 50 hectolitres. When a cell is filled with megass from the first mill, a certain proportion of cold, normal juice flows by gravity into this diffuser, and then on the top of this, to fill the cell completely, a proportion of hot limed-juice from the meichage or liming tank is admitted. The diffuser is then closed.

Connexion is then made to the circulating pump, and the cold juice is then drawn from the bottom of the diffuser through strainers and delivered by a pump through specially designed juice heaters to the liming tank and at the same time to the top of the diffuser. This circulation is repeated till the juice under treatment is raised to between 218° and 220° F. In this way the juice is completely sterilized, and the duration of the operation is under ten minutes from the time the juice is expressed from the cane. Seeing the juice is thus almost immediately sterilized as it is expressed from the cane and never exposed to the air, but enclosed completely during the whole operation until it reaches the triple effêt, the loss and risk from inversion is very small. This hot juice is then discharged into the diffuser, the top door closed, and the circulation by pump at once effected. The crushed megass in the diffuser, during this operation, acts as an excellent filtering

medium, in fact, one of the best that has yet been discovered for sugar-cane juice, as was shown by the clear and limped condition in which the diffused juice was discharged from the battery.

After the megass in the cell has been completely exhausted of all its sweet (by a washing with a small quantity of water), compressed air is admitted to the top of the cell so as to force this water through the megass into the adjoining cell, any sweet that is contained in this water being thus utilized in the succeeding operations. The bottom door of the cell (about 6 feet diameter) is then opened, and the exhausted megass falls on to a carrier running underneath the centre of battery, which receives the exhausted megass of each cell as the same is discharged. This carrier conveys the exhausted megass to another elevating carrier which supplies the feed to the second mill.

The second mill is a strong mill of modern design, having rollers 36 inches by 78 inches with extra strong gearing and powerful engine. By this mill the waste water in the megass is well extracted; and only about 48 per cent. of water being left, it burns freely and forms an excellent fuel for the boilers.

The juice from the diffusion battery is forced by a pump into a tank with central division, on the same level or platform as the normal juice tank. This allows one-half of the tank to be filled while the other half is discharging, if necessary. This tank gives the measure of juice coming from the battery and is called the triple effêt supply tank. Another tank (the meichage or saturation tank already mentioned), placed on the same level as the normal juice tank, receives a certain proportion of the juice from the diffusion battery which is to be used in the succeeding vessel for the saturation of the megass along with a certain proportion of juice from the normal juice tank.

The discharge tank from battery is sufficiently high to supply the triple effêt, and as the factory was making dark crystals for the American market the juice from this diffusion battery tank went direct into the triple effêt, thus doing away with all defecators, subsiders, and filter presses, and so reducing the sugar making to a very simple and direct operation.

The operation from the triple effêt to the vacuum pan and centrifugals remained as it was in the previous year.

The actual results obtained on Caroni fell short of what was expected, owing to the megass from the first mill not being in a suitable condition for the diffusion, this three-roller mill not having a crusher to split open the cane before entering the mill nor a shredder to shred the megass as it left the mill: the extraction of juice was not complete and the dilution was too high, so that a little extra fuel was required beyond the megass for the boiler. The next year this defect will be overcome, when, no doubt, the factory will work through the crop without any fuel beyond the exhausted megass. As it was, however, the results of the crop were much in advance of the double crushing of the previous year, a larger quantity of

sugar being produced from the same weight of canes; furthermore, at the end of the crop, the estate produced fine yellow crystals for the London market. The proprietors of the estate are satisfied that the principle of the process is correct and that, when the necessary alteration is made on the first mill, next year's operations of the Naudet process will be in every way satisfactory and will prove in every sense a commercial success.

FORTUNA ESTATE, PORTO RICO.

At the estate Fortuna, near Ponce in Porto Rico, the diffusion battery is of the same dimensions as the one just described, but the arrangement is different—that is, while there are ten cells of about 50 hectolitres capacity, as in Trinidad, these ten cells are arranged in one line, the intention being in another year or so to add another line of ten cells, so that the capacity of the estate would be doubled. On this estate the cane-crushing mill had rollers 32 inches diameter by 66 inches long, but in front of these was a Marshall crusher with large and powerful rollers which prepared the cane for the crushing in the three-roller mill; the cells of the cane being thus thoroughly opened up allowed the hot juice to act rapidly on the megass, giving thereby immediately a very high extraction, so much so that the juice from the battery was only 0·7° Beaumé less in density than the juice from the mill, the dilution being about 9 per cent. of water and for every 100 gallons of juice contained in the cane, about 93 to 94 per cent. of same was extracted, the megass being in a much better condition for diffusion than at Caroni.

On the estate Fortuna, by sulphuring the juice in addition to the liming, and passing the juice through Philippe filters from the battery, a very fair white sugar was produced, suitable for local consumption. Given a certain purity of raw juice in good working, an equal purity in diffusion juice and syrups results. At Fortuna the purity of raw juice was during the third week 84·2; purity of the diffusion juice 84·1.

When everything was going on well at Fortuna, we had an extraction of 96 to 97 per cent. This year on Messrs. Hinton & Son's sugar estate in Madeira the average extraction throughout the whole crop was 95·5 per cent; and 40 per cent. of the canes ground were Yuba or Natal canes, a very small, hard variety.

The recovery of sugar at Fortuna was good, being as under:—

		Per cent.
Sugar in cane		13·5
Recovered—First sugar	10·0	
„ Second sugar	0·5	
Sugar in molasses	1·8	
		12·3
Total loss		1·2

The fuel question, however, was not satisfactory, owing to the machinery in the factory not being able to overtake the amount of juice produced by the battery—that is the triple effêt, vacuum pan, and centrifugals were much under the power required. The boiler installation and the furnaces were also defective, so that here again extra fuel was required beyond the megass; otherwise the process was similar to what I have described as carried on at Caroni.

ADVANTAGES OF THE PROCESS.

The process of diffusion by forced circulation and methodical washing of the megass offers the following advantages:—

1. *Large extraction.*—Nearly the total amount of juice in the cane is extracted—that is, of the total juice in the cane 95 per cent. is extracted, and that with the low dilution of about 9 per cent. of water. When the megass is good and well opened up—and a dilution of 12 per cent. of water used—an extraction of 97 per cent. of the total juice in the cane is the result.

2. *Economy of fuel.*—With good steam boilers and well-arranged megass furnaces, combined with proper arrangements in the use of the steam in the factory, little or no fuel is required beyond the exhausted megass from the diffusers.

3. *Complete purification.*—The complete purification of the juice without the use of clarifiers, subsiders, eliminators, or filter presses. The juice goes direct to the evaporator or triple effêt from the battery for dark sugars, and once through mechanical filters for Demerara or yellow crystals.

4. *Economical production of white sugars.*—By the use of continuous sulphuration and proper liming of the juice, also passing the juice and the syrup through Philippe or similar filters, a very fair white sugar can be produced at very little extra cost beyond dark sugar.

5. *Small loss and complete recovery.*—As the juice is completely sterilized within about ten minutes after it is expressed from the cane by a high temperature and liming, also thereafter completely enclosed from the atmosphere, there is no loss from inversion, and thereby an increased recovery of sugar is obtained.

6. *Small pressure.*—The risk of breakdown to the mills is reduced, as no such excessive pressure is required as is necessary in double or triple crushing, as only about 60 per cent. of the juice is extracted by the mill when single crushing which does not require much pressure and gives almost a pure juice. The remaining 40 per cent. of the juice is extracted by the battery—also as pure juice—and thus the impurities resulting from double, triple, and quadruple crushing are avoided, and so less impurities require to be eliminated by this process.

7. *Simplicity.*—The whole process of sugar manufacture is much simplified; the expense and labour of washing out the clarifiers and eliminators, and the danger of this being

neglected or improperly done, are avoided. Also the expense and labour caused by the use of filter presses, and the wear and tear entailed by the cleaning of cloths, are done away with; indeed, the whole operation in the sugar factory is cleaner and more regular.

8. *High purity.*—Another important point is that the juice from the diffuser has as high a purity as the juice from the mill. This process has a great advantage where the canes are hard and dry, as in the Yuba or White Transparent cane, and in a season which is usually dry the advantage in the sugar recovered is very great as compared with the double or triple-crushing mills.

RESULTS OF THE PROCESS.

The first installation was made on the sugar estate of Messrs. Hinton & Sons, Madeira, where the process has now been at work for the last three years, effecting a great saving in fuel. Last year the average extraction for the whole crop was 95 per cent. of the juice in the cane. A very good white sugar was produced direct from the cane, which was used for local consumption and also for the manufacture of Madeira wine—showing the sugar to be of high quality.

As already stated, the result at Caroni estate, Trinidad, was short of expectations owing to the defects in the first milling, the cane not being opened up sufficiently to give good diffusion results. As it was, however, it was a gain over double crushing.

At Fortuna estate, Porto Rico, the extraction was good, the megass being in good condition, thanks to a crusher in front of the mill to open up the cane. The extraction was 96 per cent. of the total juice in the cane with a dilution of 9 per cent. on the weight of the cane, and the density of the juice from the diffusion battery was only 0·7° Beaumé less than the juice from the mill. This juice was also of equal purity to the juice from the mill.

As to the gain in sugar to be obtained by the Naudet process as compared with the present method of double or triple crushing, the following figures will speak for themselves:—

On one estate in Cuba last year, with a strong Krajewski crusher in front of the first mill, and double crushing by powerful three-roller mills, making a crop of 15,000 tons of sugar, the result was as under:—

Sugar in the cane			15·20
Loss in the megass	2·85	Loss	4·189
Loss in scums and filter presses ...	2·85		
Loss in molasses	0·779		
Undetermined losses	0·45		
Sugar obtained	11·007		
	15·196		

Total loss as above—4·189, less loss by the Naudet process; the loss estimated on the above canes would be as under:—

Loss in megass	0·500
Loss in molasses...	0·779
Undetermined losses	0·45
	1·729

4·189 less 1·729 equals a gain by the Naudet process of 2·460; the sugar obtained would therefore be 11·007 + 2·460 = 13·467. This increased extraction of sugar worked out on the same amount of canes will give, not 15,000 tons, but 18,300—a gain of 3,300, the money gain on which will depend upon the price of sugar. Say, it is £11 per ton, then allow £1 per ton for the manufacture of the juice into sugar, which will leave an extra net profit of 3,300 × 10 = £33,000.

The claims of the Naudet patent are very simple, and are as follows: 'The application of forced circulation to every succeeding cell of a series of cells of a diffusion or macerating battery is accomplished by the use of a pump, the suction side of which communicates with the bottom of the cell having straining boxes intervening to collect small pieces of cush-cush or megass that may be retained in the juice, the delivery side of the pump connected to the top of the diffusion vessel having heaters intervening between the pump and the diffusion vessel to bring the juice to the required temperature.'

There is now being erected at the Central San Jose in Cuba, belonging to Messrs. Rabel & Co., a large Naudet plant which is to treat 1,800 tons of cane per day, and this plant will be in full work by the end of the year.

The following editorial note appears in the July issue of the *International Sugar Journal*:—

The writer of the article is Mr. Robert Harvey, M.I. Mech. E., who has been out in the West Indies in conjunction with Mr. Naudet to supervise the working of the process. As his firm was responsible for designing and erecting the machinery, his knowledge of all the details is obviously of a thorough character. There is no doubt that the new process has proved a success; we have examined samples of crystals resulting from it, and they are of the highest class.

It is to be hoped that it will ere long be possible to carry on this process in a factory equipped throughout with the most up-to-date machinery in all departments, in which case we shall be in a fair position to compare the new system with the other modern systems in use in Cuba, Java, and the beet-sugar area of Europe.

SUGAR INDUSTRY IN JAMAICA.

In view of the efforts that have recently been made in Jamaica to bring about the revival of the sugar industry in that island, it may be of interest to publish recent information relative to the industry. The following notes were written for *Jamaica in 1905* by Dr. H. H. Cousins, M.A., D.Sc, F C S., Government Analytical and Agricultural Chemist:—

Formerly the chief source of the wealth and exporting capacity of Jamaica, sugar has latterly fallen to a secondary position, and now represents but a quarter of the value of the fruit exported from the island. Even adding the rum, for which Jamaica rightfully holds the reputation of producing the best in the world, the total value of the sugar-cane products exported during the past five years is little more than one-third that of the bananas and oranges shipped to the United States.

The causes of this depression of the sugar industry are not far to seek, and in so much as they are of local origin the writer has no hesitation in affirming that they are entirely remediable. The cane grown in Jamaica to-day probably contains nearly the same percentage of sugar as the cane first brought from Otaheite by Captain Bligh in 1796. Its content of sugar is quite 10 per cent. below that of the improved sugar-beets grown in Germany at the present time. There are many estates in the island producing from 12 to 15 tons of canes per acre, or the equivalent of an ordinary crop of sugar-beet. Instead of a recovery of a ton of sugar from 8 or 9 tons of produce, as in a modern sugar factory, no estate in the island works less than 11 tons, and the average is fully 16 to 18 tons of cane per ton of sugar. The writer knows of an estate where 27 tons of cane are required to produce 1 ton of sugar.

The yield of sugar per acre on estates at present in cultivation in Jamaica can be *doubled* by the most ordinary

methods and appliances. This statement is not lightly made and it errs rather in underestimation than overestimation of the problem. Some of the most obvious of these improvements are the following:—

IMPROVED CANES.

The original expectation that the sugar-cane might be as greatly improved in sugar content as the sugar-beet, by years of systematic selection of seedlings, on analysis, has not been fulfilled. Beyond a certain point—24 per cent. sucrose in the juice—any increase in richness of cane involves a reduction in agricultural yield. The line of development of the sugar-cane as a cultivated plant, lies primarily in the direction of increased tonnage of cane, and secondly, in that of greater purity of juice. Systematic work in the improvement of the cane has been carried on for some years in Demerara and Barbados.

The best of these seedlings have been tested in Jamaica, and two stand out in a prominent manner. Barbados seedling No. 208 appears well suited to all parts of Jamaica and is probably the best cane now available. At the Hope Experiment Station in 1905, a crop of this variety was harvested, yielding over 70 tons of cane, capable of yielding 7 tons of sugar per acre. Upon light soils in seasonable or irrigable districts, Demerara seedling No. 95 has proved a great success. This cane has given double the yield of crystallized sugar per acre, as compared with the Jamaica cane, and upon a commercial scale under these conditions.

Seedling canes are being raised and systematically tested on a large number of estates in Jamaica, and practical results are already apparent.

DRAINAGE.

Large stretches of the most unctuous loam ever blended in an alluvial plain are available for sugar cultivation in certain districts of the island. In the past, failure has attended sugar cultivation on certain of these lands owing to an entire failure to appreciate the vital necessity of deep and thorough drainage. With a tropical rainfall this is far more essential than in a temperate clime.

CULTIVATION.

What cultivation can do in improving the growth and production of cane has been well illustrated by the results of a few progressive sugar planters. Deep ploughing, subsoiling, green manuring with cow peas, frequent harrowing and cultivation are practices vital to the success of cane cultivation on most Jamaica soils. There are estates where good cultivation alone has turned a moribund property into a source of splendid profit to its owners.

MANURING.

At least ten times the amount of fertilizers at present applied to cane land in Jamaica is demanded in the interest of the industry. It is granted that, on lands where cultivation is neglected and the proprietor is satisfied with the minimum

crop, which an untilled and uncared-for soil is capable of producing, the use of fertilizers might result in very little financial profit. On well-tilled soils, where sugar-cane is not merely grown but cultivated, such fertilizers as basic slag or acid phosphate and nitrogenous manures could be extensively used and a remunerative increase obtained.

A proprietor recently told the writer that the use of fertilizers during the past two years has encouraged him to continue his property as a sugar estate and to secure a profit, whereas, before, he made serious losses owing to the low yield of cane.

A series of experimental plots to test the profitable manuring of the sugar-cane is being undertaken by the Board of Agriculture in all the chief sugar districts, and results applicable to each locality will soon be available to guide the planters as to the judicious use of fertilizers.

CENTRAL FACTORIES.

There are perhaps four sites in Jamaica at the present time where the erection of central factories, fed from a clientèle of contiguous estates, would enable sugar to be produced at a greatly reduced cost, but, on the whole, the majority of sugar estates in Jamaica are of sufficient size, agriculturally, to stand on their own merits and to be capable of individual development.

DEFECTIVE CRUSHING.

Nothing so strikes a stranger, when first inspecting sugar estates in Jamaica, as the enormous waste that results from the use of the many old and inefficient mills still at work in expressing the juice from the cane. The writer has seen mills that certainly resulted in a loss of 10, 15, and 20 per cent., as compared with a good single-crushing mill of modern design. On one estate, it has been shown that a mill costing £600 would express over £3,000 worth of sugar and rum-producing material per annum. It is pleasing to be able to say that the new mill has been already ordered. On large estates double crushing is a most effective process, but on small estates it is probably better policy to have one really good and powerful mill than a pair of ordinary mills. The five-roller mill, in which the cane is broken up by a preliminary crushing before passing to the three-rollers, has proved a great success and is well suited to Jamaica conditions.

The whole of the plant in the majority of Jamaica sugar works could well be replaced by new and improved fittings and utensils.

For the prospective trade with the mother country, the introduction of vacuum pans is a highly desirable step to take.

RUM.

Given efficient crushing, Jamaica has a splendid advantage in the value of rum as a means of recovering losses in the manufacture of sugar. Although some estates only recover about 60 per cent. of the sugar in the cane juice as commercia

sugar, the yield of rum from the residue may bring up the actual output to a relatively high degree of efficiency as compared with a factory where sugar alone is made.

The writer has ascertained by analysis and careful practical experiments that 14 lb. of sugar (including glucose and inverted sugar) will yield a gallon of rum at 40 over proof under good management. If 160 gallons of rum are worth more to the estate than a ton of sugar, it is obvious that an efficient sugar process is not to the interest of the estate. Jamaica rum is the best in the world, and upon the economic and commercial advantages of this by-product of our sugar industry we can in Jamaica show results that compare with those in any tropical country where the sugar-cane is grown.. Rum will enable estates of limited size to obtain such an efficiency of output that the sugar industry can be economically and profitably carried on under local conditions.

From a recent tour round sugar estates in Jamaica, it was evident that the industry is just beginning to recover from stagnation. Everywhere a feeling of hope, of confidence, and of progress is springing up.

Jamaica can grow canes at a cost of from 4*s.* to 5*s.* 6*d.* a ton in certain suitable districts. If a ton of sugar can be made from 8 or 9 tons of cane by modern methods and machinery, it is clear that there must certainly be a future for the sugar industry when it is given the benefit of such advantages.

A grievous injury to the true prosperity of the island has been brought about by the ill-informed croakings of people who have maintained that Jamaica's sugar industry is doomed, and babbled of bananas as a panacea for the financial difficulties. In the writer's opinion a capitalist seeking an outlet for his money in Jamaica could find no investment so safe, certain, and remunerative as a well-situated sugar estate managed on up-to-date lines, and with sufficient capital to work economically.

The same publication contains the following notes by 'A Sugar Planter' on sugar cultivation in the parish of Westmoreland :—

The sugar industry of Jamaica has had a very chequered career—the bounty systems of continental Europe having done their best to drive it out of most of the parishes—though, strange to say, one or two estates, or even more in some places, have held out: the parishes without any sugar estates are still few, and what made them hold out it is hard to say—whether the pertinacity of their owners, or favourable local circumstances.

In three districts, however, the sugar industry made a very hard fight for life—in Vere ; Trelawny and St. James ; Westmoreland and a part of Hanover.

In each of these districts, the conditions of rainfall and soil vary much more than we should think it possible in an island of the size of Jamaica. Vere and Trelawny and St. James often suffer from drought. In Vere, however, there is an irrigation scheme at work.

Westmoreland and the Green Island end of Hanover suffer, more than not, from excess, rather than deficiency of rain.

The conditions of cultivation have of necessity to differ much in each district; and no one more than the writer knows that the planters who live in a district have probably learnt the best way to handle cultivation under the conditions they have to contend with.

Trelawny and St. James go in largely for high-class rum; Vere and Westmoreland have no such ambition, as a rule, but usually make a home-trade rum, to be sold in the London and Jamaica markets. There are some who say it is because they cannot make high-flavoured rum. That, however, is not the writer's opinion—who thinks that they, like the Trelawny and St. James planters, have learnt what pays them best to do.

That the Jamaica sugar planter has got to the turning of the lane, there seems reason to hope.

Mr. Chamberlain's carrying through the Brussels Convention was the first piece of justice that has been given to the West Indian planter. It ensures a market for his produce free from the unfair bounty competition, and he can feel with some little pride that he is still *Civis Britannicus*, which, so far as his business was concerned, was a decided drawback in the past.

The possibility of the continental powers going back to bounties seems unlikely, the increased consumption of sugar has so largely benefited both people and governments.

The prices of to-day are due only to the partial failure of the beet-root crop, and are not likely to remain when things get normal again.

Still in the Jamaica sugar industry to-day the question of combination and improved conditions of manufacture have to be faced as elsewhere, though perhaps not so acutely, on account of the rum industry. A large set of works can be run more cheaply than a small one, which is a very important fact.

The first thing to be required for a factory—a modern one to be erected—is a constant supply of canes, one year with another; machinery does its best always when working at nearly full power. Westmoreland stands first in that respect on account of its regular rains, the tonnage of sugar-canes varying not very largely one year from another; the land, too, is fairly level, so tramways present no great difficulties. The good land unworked is, however, not a large quantity.

Two estates, however, have during the past few years been buying canes from small proprietors and others, and this plan seems to be increasing.

Vere, with good irrigation, would be second to no other place in Jamaica: it is a fine, level country, and is said to have good land.

Trelawny and St. James have no apparent chance of irrigation, and they seem too hilly for large sugar concerns.

With prospects certainly better than they have been for some time, the future of the Jamaica sugar industry greatly depends on the extent to which owners will combine and work

together on modern lines. The day of small things is certainly over, and if opportunities are not snatched, it may still be a 'sunset' industry, i.e., 'a memory rather than a hope.'

CENTRAL FACTORIES IN JAMAICA.

It may be of interest also to quote the following article from the *West India Committee Circular*, of August 8, 1905, giving information in regard to the establishment of central factories in that island:—

In a recent issue we indicated that there was a probability of a new central sugar factory being erected in the district of Vere, Jamaica, and we are now in a position to give some particulars regarding the company which has been formed, and is about to be registered in Jamaica, with this object in view. The title is 'The Vere Estates Company, Ltd.,' and the authorized share capital £100,000, in ordinary shares of £1 each, of which 70,000 are to be issued, and 6 per cent. convertible debentures to the value of £30,000. The purpose of the company is to acquire a number of estates, and to plant and cultivate sugar, cotton, and cocoa-nuts upon them, and to erect a central factory at Moreland for the manufacture of sugar and rum according to the most approved and economical methods. The estates taken over will be Raymonds, Hillside, and Moreland (sugar), Braziletto, Bogue, and Olive Park, and a portion of Chesterfield, making a total acreage of 9,556 acres, of which 1,063 are now irrigated and under cane, 2,276 available for cane and cotton, 2,180 are in guinea grass and pasture, and 4,037 in wood, ruinate, and salinas.

The London agents of the company are Messrs. E. A. dePass & Co., and arrangements have been made for Mr. C. E. deMercado, the resident partner of Messrs. Lascelles deMercado & Co., of Kingston, and Mr. Arthur W. Farquharson, to act as local directors, and to manage the company's business in Jamaica.

It is proposed to erect the Moreland factory in time for the 1907 crop, and the daily out-put of sugar is estimated at 22 tons. We understand that careful consideration will be given to the claims of the Naudet diffusion process.

The properties are contiguous, and situated on a perfectly level plain, thus facilitating cultivation on the cheapest possible scale, and economical transportation of the canes to the mill and of the finished products to the place of shipment, which is only 8 miles from the factory. The danger of injury to crops by drought has now been practically eliminated by the completion of a government system of irrigation, which is available for the whole of the 1,063 acres at present in canes. The necessary canals and trenches upon the estates have also been constructed and are in operation. Much larger crops than have hitherto been obtainable should therefore be assured.

The introduction of a system of steam-ploughing is contemplated, the soil of Vere being of extraordinary depth and

friability, and very favourably reported upon by Dr. Cousins, the Island Chemist, in this connexion. The native labour supply is fairly large and is supplemented by a number of East Indian coolies.

As to the yield of cane with full irrigation, Dr. Cousins and other experts believe 30 tons per acre, on an average, to be a reasonable estimate. The company bases its calculations, however, upon an average, year in and year out, of 25 tons per acre from the irrigated fields, and of 17 tons per acre from the unirrigated. The latter figure is approximately the actual average of the past ten years on Hillside, during which period there were four droughts, one of which caused an almost total loss of crop. It will be seen, therefore, that from the 1,000 acres of irrigated land at present in cultivation on the company's properties, 25,000 tons of canes would be produced. Dr. Cousins, reporting upon the average quality of Vere juice, states that it would require 9·74 tons of canes to produce 1 ton of sugar, and 35 gallons of rum at 40° over proof. In order, however, to provide a margin of safety, the estimated production is based upon 'Watts' Table C.,' which, allowing for 75 per cent. crushing, and 88 per cent. extraction, shows 1 ton sugar from 10·10 tons of cane. Only 33⅓ gallons of rum, or say, one puncheon (100 gallons), to every 3 tons of sugar are calculated to be produced from the by-products.

On the above basis, 25,000 tons of cane for the first year's working should produce about 2,475 tons of sugar and 825 puncheons of rum. In succeeding years the additional cultivation of 200 acres of canes from unirrigated lands would increase the production by about 336 tons sugar and 112 puncheons of rum, in which case the factory output for the seasons commencing January 1907, 1908, and 1909, respectively, would be: 2,475 tons of sugar, and 825 gallons rum; 2,811 tons sugar, 937 gallons rum; and 3,147 tons sugar, and 1,049 gallons rum. This it is hoped further to augment by judicious planting, so as to extend the crop period.

An important source of revenue is also looked for from the extended cultivation of Sea Island cotton. The experimental planting of 45 acres at Moreland has shown most satisfactory results, both as regards the quantity produced and the quality of the cotton.

The development of the Vere district of Jamaica is receiving a further impulse from the erection of another central factory on Amity Hall estate, the property of Major H. W. Mitchell. This factory, which is to be in operation by the end of the current year, is the property of another small local company, and will manufacture the canes grown on Amity Hall estate, and also upon Perrins estate, which has been acquired by Mr. A. W. Farquharson, under whose management the company in question will be.

SUGAR-CANE EXPERIMENTS IN JAMAICA.

With the view of indicating what steps are being taken to assist the sugar industry in Jamaica by means of experiments with new varieties, manures, etc.. of lecture courses for distillers, and in other ways, the following extracts from the Annual Report of the Board of Agriculture for 1904-5 are reproduced :—

IMPERIAL GRANT-IN-AID OF THE SUGAR INDUSTRY.

The experiments in cane cultivation constitute the first step in a series of experiments directed to improvement and economy in the production of sugar and rum. With the exception of the labour required for the cultivation of canes at Hope, and cost of cutting, packing and distributing canes to estates, the whole cost of the experiments mentioned above is now charged to the grant of £10,000 allotted by the Imperial Government to Jamaica out of the vote taken for the relief of the sugar industry in the West Indies.

That grant was, by Law 45 of 1903, entitled a Law to provide for the establishment and maintenance of a sugar experiment station, transferred to the Board to be applied by them, subject to the approval of the Governor-in-Privy Council, to the authorized objects.

The following table sets forth the particulars of the authorized capital and annual expenditure, and the amounts actually expended, before March 31, 1905 :—

ESTIMATES FOR SUGAR EXPERIMENT SCHEME UNDER LAW 45 OF 1903.

Imperial Grant		£10,000
Summary—Capital expenditure	£3,000	
Maintenance at £1,400 per annum for six years with accrued interest	£7,000	£10,000

	Approved.	Expended to March 31, 1905.		
Capital Expenditure—				
1. Sugar laboratory, fermentation laboratory, building, fittings and appliances ...	£1,000	£975	0	0
2. Experimental distillery temporary building, boiler, engine, small mill, vessels, experimental still, adjustable, 50 gallons	1,000	998	0	0
3. Alteration and new plant for estate distilleries	1,000	386	0	0
	£3,000	£2,359	0	0

Annual Expenditure—

Personal emoluments :—

Fermentation Chemist ...	£300	£300	0	0
Assistant to Chemist ...	70	75	0	0
Superintendent of field experiments	150	129	3	4
Three Assistants at 15*s.* per week	117	70	13	0
Total personal emoluments	£637	£574	16	4

Other Charges—

Reimbursements of travelling expenses :—					
Fermentation Chemist ...		£50	£36	9	8
Field Superintendent ...		100	100	0	0
Chemicals and apparatus ..		100	5	15	1
Manures for experiments ...		60	5	14	3
Distillery Expenses :—					
Distiller	£30				
Day labour	30	60	15	6	0
Distillery material from estates		50	15	6	10
Repairs and new plant ...		30			
Cane cultivation at Hope—Grant-in-aid of canes ...		50	48	7	2
Education—Training of distillers, ten at £10 each		100			
Printing, contingencies, and unforeseen		63	25	2	11
		£1,400	£826	18	3

The balance (including accrued interest) standing to the credit of the fund on April 1, 1905, was £7,194 14*s.* 10*d.*

It will be observed that the bulk of the appropriation to Capital Expenditure has been expended. The expenditure of £386 on account of 'Alterations and new plant for estate and distillers,' includes a sum spent on a locked still for experimental purposes on Denbigh estate.

SUGAR EXPERIMENT STATION.

The following is a summary of the work done at and in connexion with the Sugar Experiment Station.

Seedling Canes at Hope.—Sixty-seven varieties of canes were grown for further trial, while forty Jamaica seedlings, which had been selected by their field characters in 1903-4, were submitted to analysis.

The following varieties were discarded as inferior and not of promise for further trial in Jamaica :—D. 87 ; D. 1,488 ; D. 81 ; B. 347 ; B. 390 ; D. 254 ; D. 74 ; D. 80 ; D. 711 ; D. 119 ; D. 103 ; D. 212 ; D. 269 ; D. 142 ; D. 348 ; D. 790 ; D. 1,234 ; D. 755 ;

D. 2,093; D. 89; D. 2,190; D. 185; D. 1,959; B. 109; D. 1,897; D. 1,148; D. 757.

Our selected varieties for further trial are now as follows: - D. 78; B. 306; B. 379; D. 102; D. 275; D. 99; Caledonian Queen; D. 37; D. 1,483; D. 135; Bourbon; D. 1,438; Red Rose Ribbon; Green Rose Ribbon; D. 295; D. 2,260; Collins' Seedling; B. 156; D. 115; D. 896; Elephant; D. 1,640; B. 208; D. 1,439; B. 376; D. 109; D. 754; D. 95; D. 1,880; D. 1,168; B. 147; D. 116; Pooaole; D. 132; Mont Blanc; D. 145; D. 125; Otaheite.

Jamaica Seedlings, 1904. (In order of merit).—30, 3, 28, 9, 1, 24, 10, 23, 8, 2, 22, 11, 27, 19, 26, 12, 6, 16, 20, 15, 40, 34, 33, 32, 36, 38, 35, 39, 31, 37.

Of the older varieties the heaviest returns were from D. 78 with 68·8 tons of canes per acre and 14,152 lb. of sucrose in the juice.

B. 208 on a much larger area gave a return of 65·5 tons of canes. The Bourbon gave 39·5 tons of canes, and Mont Blanc 38·8 tons per acre.

The highest returns came from the Jamaica seedling of 1904, No. 30, with 74·4 tons of canes and 20,955 lb. of sucrose in the juice per acre. Seedling No. 20 gave the highest recorded content of sucrose in the juice of any variety, viz., 2·204 lb. per gallon.

The outstanding features of the year's trials are the splendid qualities of B. 208 and the promising nature of the selected Jamaica seedlings. Some 3,000 varieties of 1905 are now being selected for an analytical test next year. As these were raised from selected seedling parents interplanted with the Mont Blanc on an estate in Westmoreland (Mount Eagle) we have hopes of obtaining varieties of strong growth with the good saccharine qualities of the Mont Blanc.

Canes for Distribution.—From the experimental area of canes at Hope 85,851 tops were sent to estates for local trials. In some cases the tops arrived in bad condition owing to fermentation in the barrels; in other cases drought prevented the tops from growing. It is estimated that 28,000 of these tops actually grew and the best of our seedling canes have now been distributed to all the sugar districts of the island. The results indicate that B. 208 is the most promising seedling for general cultivation in Jamaica.

Caymanas estate, 1904-5.—The following results from Caymanas estate in St. Catherine with 2 acres of this seedling, and from Cinnamon Hill in St. James indicate the splendid quality of B. 208:—

Manager—James Wilson, Esq.
Area of plot—2 acres.
Reaped as plants—March 1905.
Variety—B. 208.
Tons of cane per acre—49·48.
Crushing by estate (five-roller) mill } 75 per cent.
Gallons juice per acre—8,296.

Sucrose per acre in juice—14,810 lb.
Glucose Ratio—6·08.
Purity—85·94.

Cinnamon Hill estate, St. James, 1904-5.

Manager—J. Shore, Esq.

	Canes per acre. Tons.
B. 208	72·3
Black Creole	23·5
White Creole	30·8
D. 116	22·0

(D. 95, D. 102, D. 254, D. 379 died out.)

It is possible to talk of the sugar industry of Barbados or of Demerara, but this is not the case with Jamaica. There are six different sugar industries in Jamaica, and it is impossible to generalize or to accept any single centre as representative of the other five. At first sight it might seem desirable to equip a Sugar Experiment Station in one of these sugar districts in which all the experiments in manuring, selection of improved canes, and the investigation of sugar and rum manufacture might be carried out. A careful study of the great variations in the agricultural and other conditions represented by the sugar estates of the island clearly demonstrates the desirability of carrying out the experiments locally under actually existing conditions of estate management. To secure the scientific and technical control of these local experiments, a central laboratory and research station is necessary.

The following plan of operation has therefore been laid down:—

Manuring of Canes.—Results already obtained show that considerable agricultural returns can be obtained in the cultivation of canes by the use of lime or marl on soils not deficient in humus and nitrogen, by the judicious use of fertilizers where the water supply enables large crops to be grown with some certainty, and lastly, of the great effect of drainage upon stiff, flat areas of land.

It is proposed to extend these experiments, to carry them out with stricter oversight and control, and to aim at the financial demonstration of the results of the operations under test.

Seedling Canes.—There are districts in the island where the seedling canes already at our disposal are capable of giving a return of at least 30 per cent. more sugar per acre than the Jamaica cane. The seasonable and irrigable areas should benefit with certainty from carefully controlled trials of the most promising seedling canes now in cultivation. Estate trials of ten varieties, specially selected for local condition, have been arranged on twelve estates.

CENTRAL LABORATORY AND STATION.

An addition to the present Government Laboratory is to be built for the special and exclusive use of the sugar work. Arrangements have been made for a sugar laboratory, a fermentation laboratory and an experimental distillery.

Sugar Laboratory.—This will be equipped for the special work of analyses of canes, juices, sugars, molasses, still-house products, rum colouring, etc.

Any estate will be entitled to the free analysis of a sample of sugar and of juice each week of the crop season.

When work permits, the staff will analyse, free, soils or other materials from estates.

All the juices from the experimental plots on estates will be analysed at the central laboratory. Experimental work on the utilization of native sugar for preserves, aërated waters, etc., will be carried out. The chemical examination of Jamaica rum will also be made a special feature.

Fermentation Laboratory.—This will be in charge of the Fermentation Chemist, and will be specially equipped for the study of yeasts and micro-organisms involved in the production of rum. This work will be carried out in direct connexion with the chemical examination in the sugar laboratory.

Experimental Distillery.—A special building and experimental plant to provide for small laboratory fermentations on a 50-gallon scale have been designed. Samples of dunder, molasses, skimmings, flavours, acid, etc., will be specially imported from estates in puncheons and barrels. Wash will be set up under various conditions and everything controlled by laboratory analyses and observations. A small 50-gallon still, with telescopic head and detachable retorts, will be constructed to deal with the various types of distillation at present existing in the island. A sufficient quantity of rum will thus be obtained to enable it to be tested commercially and chemically. Careful data as to attenuation and yields will be recorded and tables for use in Jamaica distilleries will be drawn up and made available.

Nursery for Cane Varieties.—Some 6 acres of land at the Hope Experiment Station have been established in the cultivation of cane varieties. This is to be exclusively a nursery and distributing medium; the merits of the canes will be worked out on the estates by the varietal tests. At Hope, seedling canes will be raised from selected and cross-fertilized seed, the best canes from Barbados and Demerara will be grown for distribution. To ensure the cane cultivation, it is proposed to set aside the new reservoir exclusively for the irrigation of the canes. All canes will be distributed from Hope gratis.

Education.—Special courses for the study of sugar and rum have been arranged. Ten book-keepers each year will be offered £10 each to cover the expense of attending at the laboratory n Kingston. These courses will be held out of crop.

SUGAR-CANE EXPERIMENTS AT BARBADOS.

The following account of the sugar-cane experiments carried on at Barbados under the direction of the Imperial Department of Agriculture for the season 1903-5, was presented by Mr. J. R. Bovell, F.L.S., F.C.S., Agricultural Superintendent, at a special meeting of the Barbados Agricultural Society held on Friday, November 3:—

Mr. Bovell, addressing the meeting, said that, owing to the absence of Professor d'Albuquerque, the duty had devolved on Mr. R. Radclyffe Hall and himself of laying before the members of the Agricultural Society the usual brief report on the experiments carried on at Barbados under the direction of the Imperial Department of Agriculture. These experiments consisted of two series, viz., experiments with seedling and other canes, and experiments with manures.

With regard to the first series, he mentioned that selected varieties were cultivated on fifteen estates, typical of the localities in which they were situated, twelve being black-soil and three red-soil estates. At six black-soil and two red-soil estates first ratoons were included among the plots. In almost every field the seedlings were arranged in duplicate plots, the actual number of plots being stated in the reports and in the tables appended thereto. In almost every instance each plot consisted of 100 stools arranged in four rows of twenty-five stools, and, with but few exceptions, thirty stools were cut from the inner rows, weighed and sampled. By recording the results from the inner rows only, the effects of one variety upon the growth of another and less vigorous variety were eliminated. From the thirty stools a sample of 105 lb. of canes was sent to the Government Laboratory. The juice and megass of these samples were analysed, and from these data the results were calculated to the acre.

In selecting seedling canes the most important characters are taken into consideration in determining their value. With regard to the field characters, they are :—(1) germinating power, (2) behaviour under extremes of dryness and moisture, (3) habit of the cane, i.e., whether upright or recumbent, (4) power of resisting the attacks of insects and fungi, (5) period of growth, (6) productive power, (7) weight of tops per acre, (8) ratooning power. Then there are also the factory characters, viz., (9) milling quality, i.e., whether the canes are tough or brittle, (10) fuel-producing property, depending on the percentage of fibre in the cane, (11) relative percentage of expressible juice, i.e., the juiciness or dryness of the cane, (12) the richness of the juice, (13) the purity of the juice.

As was mentioned above, the experiments were carried on on twelve estates in the black soils, and three in the red soils. The names of these estates, together with their height above sea-level and rainfall will be published in the official report.

One of the most important factors, if not the most important factor, in the productiveness of any crop is the weather. It would not therefore be amiss if we were to say something with

regard to the rainfall during the time the experiments were being carried out.

The rainfall in December 1903 and January 1904 being good, the cane cuttings, on the whole, germinated regularly, and an excellent stand was obtained at an early time. During what is usually the dry season, i.e., from February to the end of May, showery weather was experienced, and when the rainy season set in at the beginning of June, the canes were in such a condition as readily to benefit by the rain. As the weather was favourable, they made considerable progress during June, July, August, and September, but in October a drought set in, and from then till January the rainfall was much below the average. January was, on the whole, fairly showery, but from then till the end of the reaping season practically little rain fell. In spite, however, of the limited rainfall during the last three months of 1904, the canes continued to grow, due, he thought, to the fact that the soil had been thoroughly saturated at an early time; consequently, the crop, on the whole, was not so much below the average. The effect of the dry weather, however, seemed to some extent to increase the sugar-cane root disease, and he regretted to say that in many of the cane experiment plots the canes were attacked by this disease.

Before going further, he would like it to be clearly understood that any opinion expressed with regard to the value of any variety as to its suitability for muscovado manufacture or as a ratooning cane, unless otherwise stated, must be taken only to apply to the results for the season under review, as it was impossible to draw more than temporary conclusions from one season's work. With regard to the field characters, it must be borne in mind that sugar-canes, under favourable conditions, present such very different appearances from those grown during the drought and in thin, infertile soil, that it is difficult to give what would appear to every one an accurate description.

In describing the various canes in the order of the results obtained with plant canes on both black- and red-soil estates, he said he would begin with B. 1,529, the cane which gave the best results for the season under review. This cane was somewhat under the average germinating power; there were from fifteen to twenty-two rather small-sized canes to the clump with internodes from 2 to 6 inches long, which were variable, some being cylindrical and others slightly tumid. It was of an upright habit, of somewhat reddish colour and did not flower readily; the leaves were also somewhat adherent to the stem. This cane as plants, although it did not give as good results as last year, still came out first in both black and red soils. On the average in the two districts, it gave 1,603 lb of saccharose per acre more than the White Transparent. In the black soils, the yield as plants was 1,749 lb. more, on the average, than the White Transparent, and on the red soils 1,439 lb. As ratoons, however, on the black soils it gave, on the average, 698 lb, and on the red soils 597 lb., less than the White Transparent.

The next cane which gave the best results, on the average, on both black and red soils was the seedling cane B. 208. This cane germinated readily, had usually from ten to fifteen canes

to a clump, with internodes 2 to 6 inches long, somewhat cylindrical, of an upright habit and of a greenish-yellow colour. It had about the average number of arrows, and the leaves in the dry districts had a tendency to adhere to the stem.

The cane which came out third on the average for all the estates in both black- and red-soil districts was B. 379. This was a cane of good germinating power, with from fourteen to eighteen canes to the clump, internodes from 2 to 5 inches long, cylindrical in shape and of a yellowish colour. It usually arrowed freely, was of a somewhat recumbent habit, and dropped its leaves readily.

The fourth cane on the list was B. 376. This cane was also of fairly good germinating power, with eight to ten canes to the clump, internodes from 3 to 5 inches long, of medium size, but somewhat tumid. The colour was variable, like the White Transparent cane, which it much resembled in habit, in that, while under certain conditions it was somewhat recumbent, under others it was upright; it usually had about an average number of arrows. It also dropped its leaves readily.

The fifth cane was the White Transparent. The character of this cane was so well known that no reference need be made to it, beyond to state that, as last year, the results with this variety support the view that, when in sufficient number and fairly distributed, they may be taken as a reliable indication of the yield to be obtained on an estate scale, and thus afford a standard with which to compare other varieties and the seedling canes.

To compare the canes just mentioned with one another on both black- and red-soil estates, as regards the pounds of saccharose per acre, and also stated in terms of money at the average price at which sugar and molasses sold this year, and assuming that 80 per cent. of saccharose was recovered as merchantable sugar together with its molasses, he mentioned that B. 1,229 had given, on the average, 7,402 lb. of saccharose per acre, B. 208, 6,744 lb. per acre, and the White Transparent, 5,799 lb. per acre. B. 1,529 had thus given a yield of nearly 28 per cent, and B. 208, 16 per cent. more than the White Transparent. To express it in money value, B. 1,529 had given $26·41 per acre, and B. 208, $15·57 per acre more than the White Transparent. In the case of ratoons on eight estates, six in the black soils and two in the red soils, B. 208 had given $8·58 more than the White Transparent, but, on the other hand, B. 1,529 gave $14·08 less. With plant canes on the black-soil estates, B. 147 gave 1,939 lb. of saccharose, B. 1,529, 1,749 lb. of saccharose, B. 208, 711 lb. of saccharose per acre more than the White Transparent. Expressed in money value, the return from B. 147 was $31·95, B. 1,529, $28·82, and B. 208, $11·71 per acre more than from the White Transparent. Another cane of promise of which the cultivation had been extended on a few estates in the black soils, was B. 376, the average of this cane in the black soils being $3·98 per acre more than the White Transparent. With regard to first ratoons, of those in the black soils, B. 208 gave $8·18 more per acre than the White Transparent, but

B. 376 gave $5·28, and B. 1,529, $11·42 less than the White Transparent. As plant canes, on the average, on three estates in the red soils, B. 208 gave sugar to the value of $32·28, B. 1,529, $23·71, and B. 376, $10·81 more than the White Transparent, but, on the other hand, as first ratoons on two estates in the red soils, the White Transparent gave $16·27 more than B. 208, $2·85 more than B. 376, and $8·85 more than B. 1,529. With regard to the White Transparent as first ratoons in the red soils giving sugar to the value of $16·27 more than B. 208, it may not be without interest, he said, if he stated that the monetary return from the ratoons of the White Transparent, if deducted from the monetary return of the sugar from the plants of B. 208, would still leave, on the average, a profit of $16·05 for the two years, or $8·02 per acre per annum.

In addition to the canes just mentioned, there were also a number of varieties which had been cultivated during the past two years, and he called attention to a list (see pp. 357-60), from which they could see the mean results for the past two years for eighty-one varieties. Taking the average for these two years the White Transparent came out eightieth on the list, and the planter's old friend the Bourbon still lower with 1,684 lb. of saccharose per acre, even less than the White Transparent. As they all knew, it was several years before a cane that had been grown from seed could be cultivated to a sufficient extent to enable one to say what the approximate yield per acre would be. The canes on the list were most of them canes that had been grown since the Imperial Department of Agriculture had been started. The results shown, as mentioned above, were the means for the past two years, and he called attention to such canes as B. 1,753, which had given saccharose at the rate of 11,516 lb. per acre, B. 3,289 at the rate of 10,705 lb. per acre, B. 1,030 at the rate of 10,485 lb. per acre, B. 1,355 at the rate of 10,302 lb. per acre, B. 6,048 at the rate of 10,102 lb. per acre, B. 3,696 at the rate of 9,828 lb. per acre, while the White Transparent for the same two years had given 6,452 lb. of saccharose per acre. The glucose per gallon of these canes was also satisfactory, the lowest, in the case of B. 1,030, being ·044 lb. per gallon, with 2·015 lb. saccharose per gallon, and B. 1,753 contained ·055 lb. glucose per gallon, with 1·968 lb. of saccharose per gallon, while the White Transparent contained ·088 lb. of glucose per gallon with 1·908 lb. saccharose.

Continuing, Mr. Bovell said, as it was a matter of interest to all in the room, and as it confirmed the results of certain of the experiments carried out under the direction of the Imperial Department of Agriculture, he would mention that a return of the results obtained from B. 147 and the White Transparent cane, in a black-soil district, had just been kindly given him by Mr. Cameron. Before proceeding with it, however, he would like to express to Mr. Cameron the thanks of his colleague and himself for being so good as to allow them to carry on the experiments on his estates, and for the assistance he had always rendered them in connexion therewith. On the estate to which he referred 115 acres of plant canes of B. 147 had been grown, on the average, for the past three years, and

during the same time 44½ acres had been grown, on the average, each year of the White Transparent. Smaller quantities of Rappoe, Queensland Creole, Caledonian Queen, and B. 208 had also been grown. As plant canes, on the average for the three years, B. 147 had given 5,027 lb. of merchantable sugar; White Transparent, 4,707 lb.; Rappoe, 4,211; Queensland Creole, 4,656; and Caledonian Queen, 4,993. In other words, B. 147 had given 320 lb. of merchantable sugar more than the White Transparent, 816 lb. more than the Rappoe, 371 lb. more than the Queensland Creole, and 34 lb. more than the Caledonian Queen. B. 208, as stated above, had also been cultivated on the estate, and although the returns were satisfactory, as it had only been grown for two years, he had not included it.

On the same estate there had been reaped as ratoons for the past two years an average of 44 acres of B. 147, 71 acres of White Transparent, 30 acres of Caledonian Queen, 21 acres of Rappoe, and about 15 acres of Queensland Creole. Of these canes B. 147 had given 4,643 lb. of sugar; the White Transparent, 4,044 lb.; the Caledonian Queen, 4,525 lb.; the Rappoe, 4,000 lb.; and the Queensland Creole, 3,766 lb. In other words, B. 147 had given 599 lb. more than the White Transparent, 118 lb. more than the Caledonian Queen, 643 lb. more than the Rappoe, and 677 lb. more than the Queensland Creole. Taking these plants and ratoons for the average of the three years for the plants and two years for the ratoons, B. 147 gave 431 lb. of sugar per acre more than the White Transparent.

Mr. Bovell said he would now turn to the manurial plots. As they would see from the various diagrams and tables on the wall, a number of the results had been explained.

The manurial experiments had been carried on at Dodds and at four other estates situated in typical parts of the island. Of these five stations, Dodds, Foursquare, Ruby, and Hampton were in the black soils, and one, Hopewell, in the red soils. The experiments at Hopewell comprised a field of plant canes, and one of second ratoons, which had been previously manured both as plants and first ratoons. As in previous years, the plots were so arranged that the canes in one could not interfere with those in neighbouring plots, and the cultivation, though differing in details, was similar to that practised in all parts of the island. The results may therefore be taken as an indication of what would be obtained on similar fields in the same localities. The experiments were for the most part conducted, as in past years, with a view to ascertaining the effect of the application of farmyard manure, sulphate of ammonia, nitrate of soda, superphosphates, basic slag, and sulphate and nitrate of potash upon the industrial yield of the sugar-cane. Upon the whole, they indicated that an ordinary application of farmyard manure plus artificial manure is more effective than a very large application of farmyard manure without artificial manure, and that the application of nitrogen both to plants and ratoons was followed by a profitable increase in the yield. The application of sulphate of potash increased the yield, though differing on different soils, and is generally profitable. On the other hand, phosphate as superphosphate

or basic slag, for the most part, either had no effect upon the yield, or diminished the yield. In certain fields, however, an increase was indicated, but these were exceptional. The profits by manuring differed considerably, but were generally large in the case of nitrogenous manures and mostly perceptible with potassic manures. The results of previous years were therefore confirmed by this year's results. The profits by manuring given in what followed were the net profits calculated on the average price of sugar and molasses for ten years.

At Dodds the manurial plot consisted of twenty-six plots, each of $\frac{1}{20}$ acre, and was a continuation of the experiments conducted in this field since 1892. The plots that received 20 tons of farmyard manure gave 19 tons of canes. The plots that received an additional 20 tons of farmyard manure gave 24½ tons of canes, and the plot that received 20 tons of farmyard manure and artificial manure gave a yield as high as 33 tons of canes. It would appear, therefore, that artificial manures, applied after an ordinary application of farmyard manure, were more effective than very large applications of farmyard manure without artificial manures.

The plot that received minerals but no nitrogen gave 25 tons of canes. The plot that received minerals in January and 40 lb. of nitrogen as sulphate of ammonia gave 33 tons of canes, the plot that received minerals in January and 60 lb. nitrogen as dried blood in January and June gave 33½ tons of canes. The profit by manuring with 40 lb. nitrogen as sulphate of ammonia was $13·00 per acre. Nitrate of soda gave results not so favourable. Phosphate, whether as superphosphate or basic slag, led to diminished yields. The application of sulphate of potash gave an increase of 4 tons of canes and a net result of $4·60 per acre. It appears to be safe to assume that the phosphate did not directly lead to this result. Including the cost of sulphate of potash, the net profit by manuring was $23·70 per acre, and omitting the cost of the phosphate, the profit was $24·70 per acre.

At Foursquare the plots were twenty-six in number, each of the approximate area of ⅕ acre, and covering a total area of 5¼ acres. The whole field received 30 tons of farmyard manure per acre. The experiments were conducted in duplicate. The following were some of the most interesting results: No farmyard manure, 18 tons of canes per acre. An addition of 60 lb. of nitrogen as sulphate of ammonia, 24 tons per acre, or an increase of 6 tons per acre. Minerals and 40 lb. of nitrogen as sulphate of ammonia, 25½ tons per acre. Minerals and 80 lb. nitrogen, 26½ tons per acre. Thus, the application of minerals and 40 lb. of nitrogen increased the yield by 7½ tons, and the minerals and 80 lb. of nitrogen, 8½ tons of canes per acre. In the case of the nitrogen, potash, and no phosphates the yield was 23 tons of canes per acre; 100 lb. of phosphates as superphosphate, 26 tons of canes per acre. In the case of nitrogen, phosphate, and no potash, 22½ tons per acre, and 100 lb. of potash as sulphate of potash, 23 tons per acre. In this field, however, an application of minerals and sulphate of

ammonia gave an increase of 6 tons of canes and a net profit by manuring of $5·70 per acre; 100 lb. of phosphate as sulphate of potash or basic slag further increased the yield by 2 to 2½ tons of canes and a net profit of $3·00, making a total profit by manuring with potash and nitrogen of $8·70 per acre.

At Hopewell experiments with plant canes were conducted in Ten-acre Field and consisted of fifty-two plots, each of ⅐ acre, covering in all an area of 7½ acres. This field received 40 tons of farmyard manure per acre. Following this large application of farmyard manure, superphosphate produced no effect, and the application of basic slag and sulphate of potash, although increasing the yield, was not profitable; 80 lb. of nitrogen as sulphate of ammonia gave an increase of 6 tons and a net profit by manuring of $3·00 per acre.

The experiments with second ratoons were carried on in Fletcher Field and were a continuation of the experiments in the same field with plants and first ratoons. Sulphate of ammonia had given increased yields of 4 to 8 tons, and sulphate of potash 4½ to 5½ tons of cane. The application of phosphate in any form led to diminished yields.

The most favourable results in second ratoons had been given by the plots that received 50 lb. potash as sulphate and 60 lb. nitrogen as nitrate of soda and sulphate of ammonia, which had given 25½ tons of canes, as against 11⅓ tons given by the no-manure control plot. The increase by manuring had been 14 tons of canes, and the profit in 1905 by manuring was $21·00. The total increase by manuring for the three crops (plants, first and second ratoons) had been 33 tons of canes, total profit per acre of the three crops of 7½ acres.

On Hampton plantation six plots of 1 acre each were manured with farmyard manure, minerals, and varying quantities of nitrogen as sulphate of ammonia with the following results:—

Farmyard manure, minerals, and no nitrogen	19 tons.
40 lb. nitrogen	24½ „
60 lb. „	25½ „
80 lb. „	27½ „

The net profit by manuring with 80 lb. of nitrogen was $7·60 per acre.

At Ruby plantation a series of six 1-acre plots was manured with farmyard manure, nitrogen, potash, and phosphates, the last in varying forms and quantities.

The results in this case showed that neither superphosphates nor basic slag affected the yield to any extent.

There was also a series of experiments with potash carried out on Balls plantation, but he regretted to say that, owing to the field being burnt, the results had not been compiled, as it was felt that they would not be satisfactory.

In conclusion, Mr. Bovell said that he would like to express the thanks of his colleagues, Professor d'Albuquerque and Mr. R. Radclyffe Hall, and of himself, not only to Mr. A. Cameron, to whom they were especially indebted,

but to all those who had allowed them to carry on the experiments on their estates, and especially to Messrs. F. G. Inniss, W. O. and F. A. C. Collymore, T. S. Skeete, and J. Challenor Lynch, the Hons. F. J. Clarke (President of the Agricultural Society), G. L. Pile, and F. M. Alleyne, together with the managers of the various estates, of whom, he was glad to say, one and all had assisted in every way they could in carrying out the experiments.

An adjourned special meeting of the Agricultural Society was held on November 17 at the Planters' Hall for the purpose of discussing the results of the sugar-cane experiments carried on in this island for the season 1903-5, which were presented by Mr. J. R. Bovell, Agricultural Superintendent, at a meeting of the society on November 3.

The President, in opening the proceedings, said Mr. Bovell had intimated his desire to supplement the statement he made on the last occasion with reference to the sugar-cane experiments, and therefore he would at once call upon him to do so.

Mr. Bovell rose and offered a supplementary statement in connexion with the experiments based on certain figures which had been kindly given him by Mr. A. Cameron. In concluding his statement, he expressed his thanks to Mr. Cameron for his kindness in furnishing him with those figures, which he regarded as being very satisfactory and as confirming on a large estate scale the results obtained on small experiment plots.

Having concluded his statement, Mr. Bovell proceeded to initiate the discussion on the results of the experiments by giving his replies to certain questions forwarded him in connexion therewith by the Hon. G. Laurie Pile, who, he said, was unable to be present owing to indisposition.

The following are the questions and replies:—

(1) Taking into consideration the fact that as *first ratoons* the White Transparent on the hills gives a much better money return than the B. 208, would it not be safer to plant the White Transparent on a large scale when considering that it can be kept up to the fourth ratoons, whereas the B. 208 would probably fail?

Reply.—Experiments to ascertain whether B. 208 ratoons satisfactorily beyond first ratoons have not yet been undertaken, but in view of the results obtained from this cane, we consider that the proprietor of each estate on the red soils should take a fairly level field, and divide it in half, planting the White Transparent in one half and B. 208 in the other, and so ascertain definitely which gives the best results over, say, four crops, plants, first, second and third ratoons.

(2) What did the seedling B. 3,233 do this year, as it was not mentioned on the list, and do you consider it worth planting again?

Reply.—On the average of the results on two estates in 1905, B. 3,233 gave as plant canes 4,454 lb. of saccharose per acre, and as ratoons 3,181 lb. of saccharose per acre. In view of

the fact that this cane has only given as plants, on the average for the past four years, 6,075 ℔. of saccharose, as compared with White Transparent which for the same period gave 6,124 ℔. of saccharose, and also in view of the fact that there are so many new canes, which had given much better results, it is not proposed to plant this cane again.

(3) Will there be plants of the seedlings that gave high results available for the planters?

Reply.—As they are not many canes of the better varieties available, those at present growing will, after providing sufficient for the tests to be carried on in 1906, be distributed as far as possible on the estates on which experiments are being carried on.

(4) Have any experiments been carried out with nitrate of potash; and if not, would it not be interesting to have some experiments with it next season?

Reply.—Experiments with nitrate of potash to ratoons were started in 1903, and are still being carried on. The results are so far satisfactory.

Mr. Bovell next pointed out reasons why he considered planters should plant B. 208 seedling in red soils, and expressed the opinion that they would experience no difficulty in finding out whether his conclusions respecting it were correct. He added, in conclusion, that Mr. Hall had asked him to state on behalf of Professor d'Albuquerque and himself that they were always only too glad to supply to planters bottles ready prepared for taking samples of juice for analysis, and all they asked was that those who wanted such bottles should send an ordinary empty whisky bottle in exchange.

Mr. Cameron said he wanted to make it clear that the figures he had given Mr. Bovell were the results of the ordinary day's work which were tabulated at the end of each year, and represented concrete facts. He was not suggesting to anybody what cane should be planted, but was simply giving facts ascertained on estates with which he was connected. He would like to express publicly on behalf of the proprietors of estates which he represented a sense of deep obligation to Sir Daniel Morris, Mr. Bovell, Professor d'Albuquerque, and the other officers of the Department of Agriculture for the very valuable assistance that had been rendered by them in connexion with the sugar industry, and for the courtesy with which they had always listened to the inquiries of planters extending over a number of years. The members of the society were also under deep obligation to them for their very valuable service. (Cheers.)

The Hon. Sir Daniel Morris, addressing the meeting, said: Mr. President and gentlemen, Before we close our meeting this afternoon I would like to say a few words on the general situation as regards the sugar industry. It is evident, from the admirable summary of the results of the sugar-cane experiments presented by Mr. Bovell and Mr. Radclyffe Hall and the facts elicited in the discussion, that we are steadily advancing in the direction of raising new canes richer in sugar contents and more

capable of resisting disease. It is evident, also, that the methods that are being adopted to meet the requirements of the planters are well suited to attain the ends in view. Not only are the canes raised appreciated here, they are also greatly valued in other sugar-growing countries. This is especially true of cane B. 208, which is being largely cultivated in British Guiana, Jamaica, Cuba, Porto Rico, Natal, and Queensland, where it is regarded as one of the richest canes under cultivation. As I mentioned at the previous meeting, it is proposed to carry on the experiments on the present lines for three years longer. Whether they are to be continued in full after that period will depend on the position then attained and whether the members of the planting community in this island and other parts of the West Indies can convince the Imperial Government that it is still necessary to provide the means for carrying them on. It is right, however, that I should bring before you to-day and ask your earnest consideration in regard to other directions in which the position of the sugar industry in this island may be improved. It is well known that it costs from 12*s.* to 13*s.* to produce a ton of canes in Barbados. This is possibly higher than in any other cane-growing country. It is probable that the circumstances at Barbados justify this. In any case, I am not prepared at this moment to go into details and point out how canes may be grown at a lower cost. It is not unlikely that, because labour is so cheap and abundant, agricultural operations are not so closely restricted as in localities where labour is dearer; also that planters have not felt the necessity for adopting labour-saving implements and methods which are essential to the success of the industry in other parts of the world. One very prominent item at Barbados is the cost of artificial manure. I notice that Mr. Bovell, in a paper read at the Agricultural Conference of 1899, places the average cost per acre for artificial manure at $16·24 (£3 7*s.* 8*d.*). Is it established that the Barbados soil actually requires this expenditure in addition to an average expenditure per acre (also stated by Mr. Bovell) of $17·42 (£3 12*s.* 7*d.*) for farmyard manure? These items deserve to be very carefully scrutinized in the light of the results brought before you by the Imperial Department of Agriculture. It is possible that, with a larger use of first-class farmyard manure, the amount of artificial manure, for plant canes at all events, might be reduced.

During the last two or three years we have heard little or nothing of proposals to establish a pioneer Central Factory in Barbados. As you are aware, this matter was very fully gone into some time ago. Your President, in a paper read at the Agricultural Conference of 1900, expressed his opinion as follows: 'Not only must we have central factories in order to avoid the enormous loss attending the present system of manufacture by means of small and imperfect crushing machinery and open tayches, but to be able to manufacture any class of sugar that may be in demand in the markets of the world.' Further, he stated: 'It is absolutely essential to our existence that central factories should be erected here.' Professor Harrison, with his long experience of Barbados and his more recent acquaintance with the working of central factories in British Guiana, at the

same Conference, stated: 'There is not the slightest doubt in my mind that, if this colony of Barbados is to continue to exist as a sugar-producing colony, it must adopt the principle of central factories.' And further: 'All I can say is that I believe the erection of central factories in Barbados would be a means of raising the colony out of its present difficult position and, in fact, prove its salvation.' Nothing has happened since to alter the situation, and if we allow matters to drift on as at present, there is little hope of permanent improvement in the principal industry on which the safety and welfare of the community depend. In this connexion, it may be of interest if some of the results of the working of the new central factory erected at Antigua for the current year were placed on record. This factory, including 5½ miles of railway, locomotives, etc., has cost £42,408 (see *West Indian Bulletin*, Vol. VI, pp. 60-4). Particulars to hand for 1905 are as follows:—Tons of canes crushed, 15,860; gallons of diluted juice, 2,437,500; first sugar, 96° crystals, 1,603 tons; gallons of molasses, 7,700; tons of canes per ton of sugar, 9·73; price paid for canes, 11*s.* 8½*d.* per ton; cost of making a ton of first crystals, 96°, delivered on wharf, £2 15*s.* 4½*d.* According to these figures, it has required 9·73 tons of canes to yield 1 ton of 96° crystals. At Barbados, we are told, it requires 13½ tons of canes to make 1 ton of muscovado sugar. It follows that a loss of 3¾ tons of canes is incurred on every ton of muscovado sugar produced in this island. This means that with an annual average crop of 50,000 tons of sugar, the value of 187,500 tons of canes is lost through defective crushing. Further, if we take a ton of canes in Barbados as worth 12*s.*, the loss expressed in money would amount to £112,500. I admit this is an outside estimate as between the muscovado sugar produced at Barbados and the 96° crystals produced at a central factory. If, however, we estimate that only one-fourth of the Barbados crop is dealt with by a central factory, there would still be a possible saving in money value of nearly £30,000. With the present low prices, this is an appreciable amount to add to the resources of those dependent on the sugar industry. It has been urged that the establishment of central factories in Barbados would lead to the displacement of a large amount of labour and reduce the number of managers, overseers, and others. I hold in my hand a statement which has been carefully prepared at Antigua, showing the number of persons displaced owing to the establishment of the central factory in that island, including children spreading fuel, etc. The result is that, while 152 labourers and children have been displaced on the estates, 113 have been employed at the factory, leaving thirty-nine actually displaced. It is pointed out that at the factory the people employed are more skilled and command higher wages. Four managers have been displaced, but against this we have to count the manager of the factory, overseers, and chemist. It would appear, therefore, that the establishment of a pioneer factory, capable of turning out 3,000 to 5,000 tons of sugar, would not displace an appreciable proportion of workers, while the factory would add several thousand pounds increased value to the sugar produced. We

have also to bear in mind that, if we continue to produce muscovado sugar, we may later on experience great difficulty in finding a good market for it. Neither the United States nor Canada cares for raw sugar. They prefer, for refining purposes, 96° crystals; and in regard to the muscovado shipped to the United Kingdom, we have to remember that what is refined there is shipped to Canada, where it obtains the full benefit of the preferential tariff which is denied to the muscovado sugar shipped direct to Canada from the West Indies. In conclusion, I think it well to draw attention once more to the fact that we have not yet travelled over the whole ground covered by the experiments. We may raise canes to withstand disease, but if, at the same time, we lose a very large proportion of the canes we have grown, we cannot possibly place the sugar industry on such a footing as it ought to be. These experiments having been placed before you, I shall be glad if they lead to discussion to-day or at some other time, in order to show whether we cannot start a pioneer central factory in this island. (Cheers.)

Mr. S. S. Robinson asked the Imperial Commissioner whether the planters of Antigua, who were paid 11*s.* 8½*d.* per ton for their canes, had any share besides in the profits of the factory.

The Hon. Sir Daniel Morris said they were paid according to a sliding scale, and if at the end of the season they had received less than 10*s.* per ton, the first claim on the net profits of the factory was to increase the price to 10*s.* Any profit still remaining unallotted was then divided equally between the planters and the shareholders of the factory. This was more fully stated in the *West Indian Bulletin*, Vol. VI, p. 61.

Mr. G. E. Sealy said: Before we separate there is one matter which I wish to bring before the meeting in connexion with these experiments. We have all heard with great interest the report that has been read of the work done by the Imperial Department of Agriculture for the season, and the discussion which has taken place on that report. And we all must realize, if we have not done so before, the obligation which we are under, first of all to the Home Government for establishing the Imperial Department of Agriculture for the West Indies, and, secondly, to Sir Daniel Morris and his hard-working staff of officers for the good and lasting work they have done amongst us. (Cheers.) Whether they are approached with a question connected with the sugar industry, the cotton industry, the banana industry, or any other industry, the officers of the Department are always ready with their advice, not only when it is asked for but when it is thought a good thing to give their advice, such, for instance, as the address which the Hon. Sir Daniel Morris has delivered this afternoon. The report which has been read on sugar-cane experiments for the season shows very clearly the enormous scale on which this work is being carried on, but it is impossible to expect the officers of the Department to complete the work they have in hand in any given time. There are some like myself who rather dread the expiration of the period for which the Department has been appointed, and I therefore take the opportunity to

place on record our appreciation of the work done by the Department, and beg to move the following resolution: *Resolved.*—That the Barbados Agricultural Society hereby desire to place on record their appreciation of the work carried on by the Imperial Department of Agriculture for the West Indies in connexion with the sugar-cane experiments in this island, and would express the sincere hope that the Imperial Government would see its way to continue the grant in connexion with them until the scientific investigations now in hand have placed the industry on a satisfactory footing. (Cheers.)

Mr. W. H. Smith, in seconding the resolution, said: I quite endorse all that has been said by Mr. Sealy, and personally I would say that great courtesy has always been extended to me by the officers of the Department of Agriculture. Mr. Bovell on one occasion kindly came to Drax Hall and visited several fields of canes there. He was shown a great deal and readily gave me his opinion in connexion with everything submitted to him. Professor d'Albuquerque has also, in the matter of analyses, shown me similar courtesy. I therefore beg to second this resolution most heartily. With regard to seedling canes, I think we are now getting a better class than formerly. Perhaps we planters have been a little too quick to form an opinion as to their merits or demerits and have not given them the time they deserved. In the case of B. 147 it seems to be a very marked cane. There is very great demand for tops and the cultivation of it seems likely to be extended. (Cheers.)

The President said: In supporting this resolution there is very little left for me to say with regard to the interesting account Mr. Bovell has given us of these sugar-cane experiments, but I should like to express the thanks of the society for having had the privilege of listening to Mr. Bovell's address and the opportunity of discussing the results which he has so clearly placed before us. I should also like, on behalf of the society, to say how indebted we are to Sir Daniel Morris and his staff for the hard work which they have carried through so successfully in this matter of sugar-cane experiments. I do not think there are many of us, in fact, I may say there is not one of us, who will differ from the sentiments expressed by Mr. Sealy in moving his resolution. But having brought the work up to the point when it requires, say, a few years more to give some really valuable results, it would be a disaster not only to the sugar industry of Barbados but elsewhere if the operations of the Department were soon discontinued, because it seems to me that in all parts of the sugar-growing world they are looking to Sir Daniel Morris' Department in the West Indies for results in the matter of seedling canes. (Cheers.) Of course, we are not concerned with the rest of the world: they know how to take care of themselves. But as regards Barbados, it would certainly be a calamity to the sugar industry that what seems such a promise as has been held out to us should not be realized. There can be no doubt that, if time is given the seedlings such as these which we are working with, we shall get a cane that will place our industry on a prosperous footing. But, as Sir Daniel Morris has told us, there is

no good having the best cane in the world if we make a class of sugar that is not wanted, for in that case we may as well have a bad cane as we shall get no further. You will perhaps remember that some ten or twelve years ago the Legislature passed an Act providing for the erection of a pioneer central factory, but that Act was vetoed by the Colonial Office. If at that time we had had Sir Daniel Morris working with us and he had expressed himself as clearly as he has done to-day, Mr. Chamberlain would not have disallowed that Act, and to-day we should have had full knowledge as to whether or not central factories were the best things for our industry. (Cheers.) It gives me great gratification, therefore, to hear Sir Daniel Morris strike the true note with regard to central factories. I think it is the first time Sir Daniel Morris has in public expressed himself so clearly as he has done to-day on the subject of central factories. And I am certain, if we should make another attempt to establish a central factory in this island, that, with Sir Daniel Morris to help us, we shall not meet another rebuff. (Loud cheers.)

The resolution was then put to the meeting and carried unanimously.

On the motion of Mr. Sealy, seconded by Mr. Smith, another resolution was adopted to the effect that a copy of the first resolution be forwarded to his Excellency the Governor with a request that it be sent to the Secretary of State for the Colonies.

Some Facts about Seedling Canes B. 147 and B. 208.

In the course of the statement read at the meeting of the Agricultural Society held at the Planters' Hall on Friday, November 17, 1905, in continuation of the report on the Sugar-cane Experiments for the season 1903-5, read at the meeting of the society held on Friday, November 3, 1905, Mr. Bovell, addressing the meeting, said he would like to make a few remarks with reference to the figures Mr. Cameron had been good enough to give him at the meeting that day fortnight. He had on that occasion mentioned the results obtained on an estate, which he would designate as 'A.,' both as plant canes for three years and ratoons for two years, and he had shown that, on the average for the three years as plants and two years as ratoons, B. 147 had given 431 lb. of sugar per acre more than the White Transparent. The estate to which he referred reaped something like 480 acres annually. At \$1·25 per 100 lb. for dark crystals (about the average price for the past three years) the value of the sugar obtained from, say, 480 acres of the B. 147, after deducting £2 10s. as the cost of manufacture, over the White Transparent, would have been about £520 per annum. In other words, it would mean that under the conditions which prevailed, an estate reaping about 480 acres would make an extra profit of £520 per annum, if it were planted in B. 147, instead of White Transparent. Mr. Cameron had also been so good as to furnish him with figures from other estates, which confirmed those just given. On one estate, which he would refer to as 'B.,' plant canes of

B. 147 had, on the average of the past two years, given 5,029 lb. of sugar, while the White Transparent had given 5,023 lb. As ratoons on the same estate for the same two years on the average for two years, B. 147 had given 4,245 lb., and the White Transparent 3,635 lb. of sugar per acre. So there was a difference in favour of B. 147 over the White Transparent of 616 lb. of sugar per acre on the average as plants and ratoons. On another estate, 'C.,' on the average for two years as plants and two years as ratoons, B. 147 had given, on the average, 178 lb. sugar more than the White Transparent. On a third estate, 'D.,' on the average for two years as plants and two years as ratoons, B. 147 had given 383 lb. sugar more per acre than the White Transparent. He was very grateful, and he was sure his colleagues also were, to Mr. Cameron for these figures, which confirmed on an estate scale what was found on the small experiment plots. He would like to supplement what he had mentioned at the last meeting with regard to the good results obtained from B. 208. As no doubt some of the members present knew, this cane was at present being cultivated in, amongst other countries, Jamaica and Queensland. Dr. Cousins, in his report on the sugar-cane experiments at Jamaica for the last year, says: 'B. 208 on a much larger area gave a return of 66·5 tons canes. The Bourbon gave 39·5 tons of canes, and Mont Blanc 33·8 tons per acre.' Further on in the report he says: 'The outstanding features of the year's trials are the splendid qualities of B. 208 and the promising nature of the selected Jamaica seedling.' In Queensland, Mr. Edward Grimley, in a paper on the 'Improvement of Plants,' read before the Agricultural Conference held at Queensland last May, referring to B. 208, says: 'We have now a report from Messrs. Gibson, of Bingera, which gives a return of 69 tons, 6 cwt. of cane per acre, with 22·2 per cent. of sucrose and Brix 23·9, or 21·45 per cent. of possible obtainable cane sugar, or over 14 tons to the acre. These results were obtained under irrigation, and the experiment plot was well manured. The average yield in Queensland per acre for the last seven years was 13·16 tons, so that B. 208 gave more sugar per acre than the average tons of canes per acre in Queensland.' In conclusion, Mr. Bovell said that planters in the red soils should cultivate more of the B. 208, so as to ascertain whether or not this cane is an acquisition. To do this, what was necessary was for a planter to grow, say, an acre of B. 208 in the same field with the White Transparent, or even half a field of each variety, taking care that the conditions in which the canes were planted were the same for both varieties. Each acre or half field could be reaped by itself, crushed separately, the juice measured, and a sample of each sent to the Government Laboratory, as he was quite sure Professor d'Albuquerque would be only too pleased to supply them with ready-prepared bottles for the samples, and to furnish them with analyses of their samples.

In reply to a question from the President, as to whether any one present desired to ask Mr. Bovell anything, Mr. Cameron said that for many years past, under the advice, and with the assistance, of Professor d'Albuquerque and Mr. Bovell, a system had been started on his estates for recording results

of each day's work. At the end of the crop these daily records were tabulated, and the figures consequently were in no way estimates—they were absolute concrete facts—nothing less, nothing more. He had much pleasure in handing Mr. Bovell statements from three estates, giving records of results obtained for the last three years from each variety of cane planted on these three estates. At the same time he wished to make it absolutely clear that he was only giving his own experience of certain canes, as grown on the estates under his charge; he was in no way telling any one what canes they were to plant or not to plant. Before sitting down, he would like, on behalf of himself and of the proprietors of the estates which he represented, to express publicly the sense of deep obligation which they all felt to Sir Daniel Morris and his Department, and most especially to Professor d'Albuquerque and Mr. Bovell, for the very great and valuable assistance and help he had received from their hands for so many years past, and for the kindness and courtesy with which they had invariably received all his applications for information. Personally, he was of opinion that the whole sugar-growing community was under a deep obligation to Professor d'Albuquerque and Mr. Bovell for the light their valuable work had thrown on the matter of the selection and cultivation of the sugar-cane.

VARIETIES ARRANGED ACCORDING TO YIELD OF SACCHAROSE.

Black Soils.—Plants.

SHOWING THE RESULTS OBTAINED DURING TWO YEARS FROM THE NEWEST SEEDLING CANES AS COMPARED WITH THE OLDER SEEDLING CANES, SUCH AS B. 147 AND B. 208, AND THE ORDINARY VARIETIES, SUCH AS WHITE TRANSPARENT AND BOURBON.

Name of Cane.	No. of years under experiment.	No. of plots reaped.	Tons per acre.	Saccharose. Pounds per gallon.	Glucose. Pounds per gallon.	Saccharose. Pounds per acre.
B. 1,753 ...	2	2	50·17	1·968	·055	11,516
B. 3,289 ...	2	2	42·34	2·007	·052	10,725
B. 1,030 ..	2	2	43·77	2·015	·044	10,485
B. 1,355 ..	2	2	38·89	2·045	·050	10,302
5 B. 6,048 ...	2	2	38·23	2·024	·053	10,102
B. 3,696 ...	2	2	38·45	1·970	·053	9,828
B. 3,708 ...	2	2	40·65	1·847	·066	9,493
B. 1,528 ...	2	2	36·95	1·965	·056	9,313
B. 1,376 .	2	2	35·38	2·094	·046	9,282
10 B. 3,819 ...	2	2	40·95	1·847	·083	9,161
B. 4,028 ...	2	2	43·08	1·706	·083	9,148
B. 3,209 ...	2	2	33·65	2·069	·044	8,798
B. 4,596 ...	2	2	38·00	1·811	·073	8,723
B. 4,164 ...	2	2	44·36	1·591	·146	8,714
15 B. 5,062 ...	2	2	37·11	1·935	·050	8,680
B. 5,078 ...	2	2	45·59	1·531	·132	8,677
B. 3,838 ...	2	2	37·90	1·789	·086	8,509
B. 1,529 ...	2	2	28·92	2·406	·031	8,477
B. 3,207 ...	2	2	33·06	2·023	·047	8,466
20 B. 3,781 ...	2	2	31·24	2·073	·046	8,409

VARIETIES ARRANGED ACCORDING TO YIELD OF SACCHAROSE.
BLACK SOILS.—PLANTS.—*Continued.*

	Name of Cane.	No. of years under experiment.	No. of plots reaped.	Tons per acre.	Saccharose. Pounds per gallon.	Glucose. Pounds per gallon.	Saccharose. Pounds per acre.
	B. 1,283 ...	2	2	35·27	1·937	·054	8,309
	B. 3,853 ...	2	2	35·01	1·804	·079	8,300
	B. 1,233 ...	2	2	33·62	1·923	·056	8,246
	B. 3,635 ...	2	2	31·90	2·044	·047	8,039
25	B. 3,750 ...	2	2	31·52	1·893	·108	7,935
	B. 5,066 ...	2	2	33·44	1·952	·051	7,854
	B. 3,859 ..	2	2	37·56	1·721	·104	7,835
	B. 5,068 ...	2	2	34·83	1·750	·086	7,829
	B. 4,769 ..	2	2	31·50	1·936	·083	7,810
30	B. 2,942 ...	2	2	30·67	2·019	·057	7,778
	B. 3,729 ...	2	2	30·39	2·002	·054	7,771
	B. 1,809 ...	2	2	31·46	2·028	·056	7,762
	B. 3,211 ..	2	3	29·58	2·064	·049	7,758
	B. 3,224 ..	2	2	29·37	2·035	·059	7,668
35	B. 3,656 ..	2	2	31·74	1·918	·060	7,666
	B. 3,381 ..	2	4	29·46	2·246	·057	7,596
	B. 5,758 ...	2	2	29·33	2·064	·058	7,589
	B. 3,700 ...	2	2	30·10	1·984	·043	7,572
	B. 3,198 ...	2	2	32·98	2·086	·047	7,420
40	B. 3,686 ...	2	2	35·10	1·732	·080	7,416
	B. 2,652 ...	2	2	32·58	1·701	·092	7,340
	B. 3,921 ...	2	2	33·80	1·718	·098	7,318
	B. 147 ...	2	9	29·76	1·876	·072	7,205

VARIETIES ARRANGED ACCORDING TO YIELD OF SACCHAROSE. BLACK SOILS.—PLANTS.—*Continued.*

Name of Cane.	No. of years under experiment.	No. of plots reaped.	Tons per acre.	Saccharose. Pounds per gallon.	Glucose. Pounds per gallon.	Saccharose. Pounds per acre.
B. 3,018 ...	2	2	29·19	1·889	·079	7,272
45 B. 4,998 ...	2	2	30·48	1·863	·072	7,218
B. 3,681 ...	2	2	29·11	1·915	·057	7,180
B. 4,985 ..	2	2	32·07	1·818	·067	7,138
B. 2,550 ...	2	3	28·74	1·895	·077	7,128
B. 3,735 ...	2	2	28·72	2·071	·060	7,125
50 B. 4,296 ..	2	2	38·72	1·418	·157	7,122
B. 4,030 ..	2	2	35·26	1·595	·116	7,111
Burke .	2	3	30·75	1·756	·082	7,108
B. 3,208 ...	2	4	27·64	2·131	·049	7,106
B. 5,076 ...	2	2	31·23	2·050	·046	7,072
55 B. 4,844 ...	2	2	29·88	1·912	·077	7,053
B. 3,852 ...	2	2	29·98	1·667	·094	6,981
B. 5,201 ...	2	2	26·45	2·058	·058	6,957
B. 208 ...	2	27	23·89	2·331	·040	6,938
B. 3,509 ..	2	2	26·77	2·193	·044	6,938
60 B. 3,465 ...	2	2	28·99	2·000	·058	6,872
B. 4,086 ...	2	2	31·44	2·196	·038	6,849
B. 1,475 ...	2	2	26·84	2·052	·049	6,829
B. 5,102 ...	2	2	29·42	1·946	·062	6,818
B. 5,358 ...	2	2	26·57	1·967	·067	6,791
65 B. 3,876 ...	2	2	29·71	1·641	·132	6,756
B. 1,607 ...	2	5	27·48	1·941	·062	6,731

VARIETIES ARRANGED ACCORDING TO YIELD OF SACCHAROSE.
BLACK SOILS.—PLANTS.—*Concluded.*

Name of Cane.	No. of years under experiment.	No. of plots reaped.	Tons per acre.	Saccharose. Pounds per gallon.	Glucose. Pounds per gallon.	Saccharose. Pounds per acre.
B. 3,667 ..	2	2	27·30	2·062	·048	6,724
B. 393 ..	2	7	26·65	1·969	·051	6,689
B. 2,819 ...	2	2	25·91	2·015	·050	6,669
70 B. 5,588 ...	2	2	29·26	1·987	·060	6,627
B. 4,287 ...	2	2	32 08	1·678	·101	6,590
B. 4,117 ...	2	2	37·23	1·407	·126	6,572
Jamaica Cane	2	2	26·89	1·962	·042	6,561
B. 3,425 ..	2	2	28·05	1·938	·075	6,537
75 B. 3,701	2	2	31·21	1·758	·092	6,525
D. 95 ...	2	4	24·87	2·025	·043	6,520
B. 3,213 ...	2	3	26·06	1·981	·061	6,505
B. 3,661 ...	2	2	30·55	1·682	·096	6,504
White Transparent	2	43	26·30	1·903	·083	6,452
80 Bourbon ...	2	2	21·18	1·785	·112	4,768

MANURIAL EXPERIMENTS WITH SUGAR-CANE IN THE LEEWARD ISLANDS.

The following information is extracted from the report on the experiments carried on with the sugar-cane in the Leeward Islands during the season 1904-5. It deals with the results of five years' experiments with plant canes and four years' work with ratoons :—

The work done during the season 1904-5 largely consisted in carrying on for another year the series of manurial experiments originally laid down in 1900; some additional and collateral experiments have been introduced.

In this work it has been sought, by a manifold repetition of a large number of experiments repeated year after year, to ascertain the manurial requirements of the sugar-cane in the Leeward Islands. These experiments have now been repeated for five years in the case of plant canes, and each experiment has been conducted on ten plots each year, so that the results now obtained represent the repetition for forty-eight times of each experiment with plant canes. This frequent repetition is sufficiently extensive to eliminate the errors incidental to work of this kind and, as the results are uniform and definite, it is now proposed to discontinue the work in connexion with plant canes. The work with ratoon canes will be continued, for there remain various problems of some practical importance yet to be solved.

In the season under review, the thirty-three manurial experiments described below have been repeated as follows :—

a. Plant canes, Antigua, 3 stations, 33 experiments, each in duplicate.

Plant canes, St. Kitt's, 2 stations, 33 experiments, each in duplicate.

b. Ratoon canes, Antigua, 3 stations, 33 experiments each in duplicate.

Ratoon canes, St. Kitt's, 2 stations, 33 experiments, each in duplicate.

Each experiment was therefore repeated ten times with plant canes and ten times with ratoons in this season.

LIST OF MANURIAL EXPERIMENTS.

1. No manure plots.

2. Pen manure plots, each receiving 20 tons of pen manure per acre.

NITROGEN SERIES.

(a.) With Potash and Phosphate.

Each plot received a dressing of basic phosphate conveying 40 lb. of phosphoric acid (P_2O_5), and sulphate of potash conveying 60 lb. of potash (K_2O), per acre. On these the following experiments were conducted :—

3. No nitrogen.
4. 40 lb. nitrogen as sulphate of ammonia in one application.
5. 40 lb. nitrogen as sulphate of ammonia in two applications—(i) 20 lb., (ii) 20 lb.
6. 60 lb. nitrogen as sulphate of ammonia in one application.
7. 60 lb. nitrogen as sulphate of ammonia in two applications—(i) 20 lb., (ii) 40 lb.
8. 40 lb. nitrogen as nitrate of soda in one application.
9. 40 lb. nitrogen as nitrate of soda in two applications—(i) 20 lb., (ii) 20 lb.
10. 60 lb. nitrogen as nitrate of soda in one application.
11. 60 lb. nitrogen as nitrate of soda in two applications—(i) 20 lb., (ii) 40 lb.
12. 60 lb. nitrogen as dried blood in one application.

(b.) With Potash only.

13. 60 lb. nitrogen as sulphate of ammonia in two applications—(i) 20 lb., (ii) 40 lb.

(c.) Without Potash and Phosphate.

14. 60 lb. nitrogen as sulphate of ammonia in one application
15. 60 lb. nitrogen as sulphate of ammonia in two applications—(i) 20 lb., (ii) 40 lb.
16. 60 lb. nitrogen as nitrate of soda in one application.
17. 60 lb. nitrogen as nitrate of soda in two applications—(i) 20 lb., (ii) 40 lb.

PHOSPHATE SERIES.

Each plot, save one, received a dressing of sulphate of ammonia supplying 60 lb. nitrogen, and sulphate of potash supplying 60 lb. of potash per acre, and the following experiments were conducted:—

18. No phosphate.
19. No phosphate: with potash and nitrogen, the latter in two applications - (i) 20 lb., (ii) 40 lb.
20. 40 lb. phosphoric acid as basic phosphate.
21. 60 lb. phosphoric acid as basic phosphate.
22. 80 lb. phosphoric acid as basic phosphate.
23. 40 lb. phosphoric acid as basic phosphate without nitrogen and potash.
24. 40 lb. phosphoric acid as superphosphate.
25. 60 lb. phosphoric acid as superphosphate.

POTASH SERIES.

Each plot, save one, received a dressing of sulphate of ammonia conveying 60 lb. nitrogen, and of basic phosphate conveying 40 lb. of phosphoric acid, per acre. The following experiments were conducted:—

26. No potash.
27. 20 lb. potash as sulphate.
28. 40 lb. potash as sulphate.
29. 60 lb. potash as sulphate.
30. 60 lb. potash without nitrogen and phosphate.

Guano Series.

Ohlendorff's Dissolved Peruvian Guano.

31. 2 cwt. guano in one application.
32. 4 cwt. guano in one application.
33. 4 cwt. guano in two applications—(1) 2 cwt., (ii) 2 cwt.

The comparisons of the yields from the various plots are based upon the weight of canes, it having been shown in our previous reports that this method gives satisfactory results.

In Antigua the rainfall was very deficient, so that the yield of cane was small at Cassada Garden, Parham New Work, and Bendal's. Of the three Parham New Work fared best in this respect. Buckley's and Molineux in St. Kitt's had good weather, thus the weight of cane per acre is higher at these two stations.

In all cases the fields under experiment were prepared in the usual manner: in Antigua they received applications of pen manure, in St. Kitt's no pen manure was used.

The experiments throughout the series, including those with pen manure, are experiments to ascertain the effect of manures used in addition to the agricultural practice now in vogue in the Leeward Islands.

Summary of Five Years' Work with Plant Canes.

Table I. and Diagram 1 give the average returns obtained during five years, each experiment being repeated ten times in each season: each experiment has therefore been repeated forty-eight times. We think that this repetition, with reasonably concordant results, may be held to afford safe and reliable information for the guidance of planters.

In the table and diagram canes have been valued at $2·60 (10*s.* 10*d.*) per ton: in the table a column is given showing the monetary loss on manuring.

Taking the averages of the results of these experiments, each repeated forty-eight times during five years, in no single case is there a monetary gain from the use of manures, but always a loss.

The information before us in Table I. enables us to ascertain with some degree of accuracy the effect of the various manurial constituents.

Taking first nitrogenous manures in combination with phosphate and potash, we see that 40 lb. of nitrogen as sulphate

of ammonia in one application (Experiment 4) increase the yield over the no-nitrogen plot by 1·5 tons, while, when the 40 lb. are given in divided doses (Experiment 5), the increase is 1·0 ton. When 40 lb. of nitrogen are given as nitrate of soda with phosphate and potash (Experiments 8 and 9), the increment over the no-nitrogen plot is 1·3 tons of cane, the same results being obtained whether the 40 lb. are given in one application or in two applications.

Where 60 lb. of nitrogen as sulphate of ammonia are given in combination with phosphate and potash (Experiment 6), the increment over the no-nitrogen plot is 1·9 tons, and 2·0 tons when the nitrogen is given in two doses (Experiment 7). With nitrate of soda in one application (Experiment 10), the increment is 1·6 tons, and when given in two doses 2·6 tons (Experiment 11).

Sixty pounds of nitrogen as dried blood with phosphate and potash (Experiment 12) increase the yield of cane by ·9 ton, over the plot receiving phosphate and potash and no nitrogen.

When nitrogenous manures are given without phosphate and potash, we find that 60 lb. of nitrogen as sulphate of ammonia in one application (Experiment 14) increase the yield only by ·1 ton. When given in two doses (Experiment 15), the increase is ·7 ton. Similarly, 60 lb. of nitrogen as nitrate of soda in one application (Experiment 16) have only given an increase of ·1 ton, when given in one dose, and ·2 ton when given in two doses (Experiment 17).

In other words, nitrogenous manures, when given alone to plant canes already properly manured with pen manure, have been without effect, and when given in combination with phosphate and potash the effect has been small: in both cases the applications are unremunerative.

Still referring to Table I., we may ascertain the effect of phosphates. Experiment 18 received potash and nitrogen without phosphate, the other experiments in this series are compared with this. Experiment 19 received the same manures as 18, but the nitrogen was given in two applications: the difference in the yield is trifling, only ·5 ton of cane per acre.

The addition of 40 lb. of phosphoric acid, as basic phosphate, to the nitrogen and potash (Experiment 20) results in an increased yield of 1·4 tons of cane. Increasing the phosphoric acid to 60 lb. (Experiment 21) increases the yield by 2·1 tons; the use of 80 lb. of phosphoric acid (Experiment 22) gives no further increase of cane, the result being practically identical with that obtained from the use of 60 lb. In Experiments 24 and 25, superphosphate is substituted for basic phosphate and applied in conjunction with nitrogen and potash: in Experiment 24, there are applied 40 lb. of phosphoric acid, and 60 lb. are given in Experiment 25, the yields are identical in both cases, the increase due to the phosphoric acid being 1·8 tons.

These results show that small applications of phosphoric acid slightly increase the yield of cane, that larger applications do not give rise to further increases, and that the effects of both forms of phosphate, that is, basic phosphate and superphosphate, are closely similar.

When phosphoric acid, in the form of basic phosphate, is used without nitrogen and potash, it does not increase the yield but rather diminishes it.

We therefore conclude that the use of phosphoric acid, either as basic phosphate or as superphosphate, when given to plant canes, which have already received pen manure, is unremunerative.

Potash slightly increases the yield, but not in a remunerative degree. Experiment 26 received nitrogen and phosphate and is used to compare with the plots receiving potash in addition to these manures. From Experiments 27, 28, and 29, we see that 20 lb. of potash increase the yield of cane by ·4 ton; 40 lb. by 1·7 tons, and 60 lb. by 1·4 tons. The increases are small and are insufficient to make the manures remunerative. It would appear that no advantage is to be gained from large applications of potash.

Potash applied alone, without nitrogen and phosphate, fails to increase the yield, the result being less than when no manure is given.

The use of 2 cwt. of guano increases the yield by ·6 ton; 4 cwt., in one application, by 1·9 tons, and 4 cwt., in two applications of 2 cwt. each, by 1·6 tons. These are unremunerative.

It must be remembered that all the above experiments were laid out on fields which had already received the applications of pen manure usual in the Leeward Islands. The experiments were therefore designed to ascertain whether additional manures were required for plant canes. The answer plainly is that they are not.

These experiments on plant canes are being repeated once more, after which they will be discontinued, it being felt that the results arrived at are definite and conclusive, while other lines of work demand attention.

Summary of the Results of Four Years' Work with Ratoon Canes.

These experiments were conducted on the plots from which the plant canes under experiment were reaped the previous season; in each case similar manures were applied to those which were used in the plant cane experiments.

The experiments with ratoon canes have been carried on for four years, during which time each of the experiments has been repeated thirty times. The accumulation of so large a number of results affords data from which conclusions may be drawn with some degree of assurance.

The average results obtained during four years in the case of each experiment are given in Table II. and in Diagram 2. An examination of this diagram and of the table at once shows that many of the applications of manure in the various experiments have proved distinctly remunerative.

NITROGEN SERIES.

Nitrogen is seen to be the factor of greatest importance, and its use to be essential, to the profitable growing of ratoon canes.

It has been experimented with in three forms: as sulphate of ammonia, as nitrate of soda, and as dried blood; it has been used alone and in combination with phosphate and potash, and its effect has also been studied when given in one application or in divided doses.

Taking the last point first, our experiments include six pairs, namely, Nos. 4 and 5, Nos. 6 and 7, Nos. 8 and 9, Nos. 10 and 11, Nos. 14 and 15, Nos. 16 and 17. The experiments in each pair differ from each other only in the fact that in one case the nitrogen is given in one application, in the other it is divided into two; the actual manures given being the same in each pair. In every instance it is seen that a better yield is obtained by giving the nitrogen in one dose, and this under all the varied circumstances of large and small applications, of use with and without phosphate and potash, and both in the case of sulphate of ammonia and of nitrate of soda.

The effect on the monetary result of dividing the dose of nitrogen is striking. In the case of sulphate of ammonia, in conjunction with phosphate and potash, 40 ℔. of nitrogen in one dose afford a gain of 7*s.* 11*d.* per acre, but when the dose is divided there is a loss of 6*s.* 2*d.* With 60 ℔. in one dose there results a gain of 9*s.* 1*d.* per acre; dividing the application results in a loss of 8*s.* 2*d.*

When nitrate of soda has been used in conjunction with phosphate and potash, 40 ℔. of nitrogen in one dose afford a gain of 14*s.* per acre, which falls to 4*s.* 3*d.* when the dose is divided. Similarly, 60 ℔. in one dose give a gain of 12*s.* 10*d.*, while dividing the dose reduces this to 4*s.* 2*d.*

Where the nitrogenous manures were used without phosphate and potash, the use of 60 ℔. of nitrogen, as sulphate of ammonia, in one application gives a gain of 22*s.* per acre, which falls to 11*s.* 2*d.* when the dose is divided. A similar result is obtained when 60 ℔. of nitrogen as nitrate of soda are used, the gains being 27*s.* 11*d.* and 13*s.* 10*d.*, respectively.

These results demand serious attention on the part of planters.

Experiments Nos. 6, 7, 10. and 11 differ from Nos. 14, 15, 16, and 17, in that in the former series nitrogen is used in conjunction with phosphate and potash, in the latter nitrogen is used alone. Comparing Nos. 6 and 14, which are parallel experiments, we see that the use of phosphate and potash increases the yield only by ·8 ton of cane per acre, and the gain is 12*s.* 11*d.* greater when phosphate and potash are omitted, owing to the cost of the latter. Similarly, in the other cases, comparing Nos. 7 and 15, phosphate and potash increase the yield by ·2 ton, but the monetary gain is increased by 19*s.* 4*d.* by their omission. In the case of Nos. 10 and 16, the increase due to phosphate and potash is

only ·6 tons; their omission increases the monetary gain by 15*s.* 1*d.*, and finally, in Nos. 11 and 17, phosphate and potash increase the yield by ·9 ton, and their omission increases the yield by 9*s.* 8*d.* per acre.

These results are concordant and show that it is more remunerative to use nitrogen alone, without phosphate and potash.

The question as to the best form of nitrogen may now be discussed. Slow-acting forms of nitrogen, such as dried blood (Experiment 12) and guano (Experiments 31, 32, and 33), are not satisfactory; rapidly acting forms, such as sulphate of ammonia and nitrate of soda, are preferable.

The information at our disposal enables us to compare the relative merits of sulphate of ammonia and of nitrate of soda. Experiments 4, 5, 6, 7, 14, and 15 received sulphate of ammonia, while a parallel series, Nos. 8, 9, 10, 11, 16, and 17 received nitrate of soda. Taking the mean results of each series, we find that the sulphate of ammonia plots have yielded 16·55 tons of cane per acre, and the nitrate of soda plots 16·97, a gain of only ·42 ton per acre in favour of nitrate of soda. This comparison has some weight, in that it is a comparison of the results of 228 plots in each class, 456 plots in all. It is thus recognized that there is a slight gain in favour of nitrate of soda.

Finally, we may discuss the quantity of nitrogen which should be applied. Plots 4, 5, 8, and 9 each received 40 lb. of nitrogen, two of them as sulphate of ammonia and two as nitrate of soda; they all received phosphate and potash, while the parallel plots 6, 7, 10, and 11 each received 60 lb. of nitrogen. Taking the means of the two groups, we find that the additional 20 lb. of nitrogen have increased the yield by only 1·1 tons per acre: the increment has a value of about 12*s.*, while 20 lb. of nitrogen cost about 25*s.* We arrive at a similar result if we compare the various pairs of experiments. Thus, the gains from the use of the extra 20 lb. of nitrogen in the various pairs are as follows: Nos. 4 and 6 gain 1·3 tons, Nos. 5 and 7 gain 1·0 ton, Nos. 8 and 10 gain 1·0 ton, Nos. 9 and 11 gain 1·1 tons. In no instance is the gain sufficient to compensate for the cost of the additional nitrogen. From this it would appear that the smaller application is the more remunerative. It would be well if we had additional experiments using 40 lb. of nitrogen without phosphate and potash.

PHOSPHATE SERIES.

We have already seen, when discussing the nitrogen series that the use of phosphate and potash does not increase the yield in a remunerative degree. This is borne out in the phosphate series where the greatest monetary gain is obtained from Experiment 18, where no phosphate is used. With basic phosphate there is a very trifling increase of ·6 ton of cane from the use of 40 lb. and 60 lb. of phosphoric acid, and which falls to ·2 ton when 80 lb. are used. The monetary gain diminishes as the phosphate is increased.

Basic phosphate used alone has not affected the yield. The no-manure plots (No. 1) and the basic phosphate plots (No. 28) have both yielded 11·5 tons of cane. The value of the manure, 7*s.* 10*d.* per acre, is thus lost.

When superphosphate is used, the results are somewhat similar. The use of 40 lb. of phosphoric acid in this form has not increased the yield as compared with the no-phosphate plot. The use of 60 lb. has increased the yield by 1·1 tons. The use of superphosphate does not prove remunerative. It is, however, interesting to note that the largest yields of cane in the whole series of experiments have resulted from Experiment 25, which received sulphate of ammonia, sulphate of potash, and superphosphate, supplying 60 lb. of nitrogen, 60 lb. of potash, and 60 lb. of phosphoric acid. The monetary results are, however, far less satisfactory than in those cases where nitrogen is used alone.

POTASH SERIES.

The use of potash increases the yield of cane in a small degree when applied in conjunction with nitrogen and phosphate, 20 lb. producing an increase of ·4 ton; 40 lb. of ·5 ton; and 60 lb. of 1·2 tons. These increases are insufficient to pay for the additional potash. This supports the conclusion arrived at when discussing the nitrogen series.

When sulphate of potash is applied alone, without nitrogen and phosphate (Experimennt 30), the yield is exactly the same as from the no-manure plots, namely, 11·5 tons of cane per acre; the value of the manure, 13*s.* 9*d.*, is therefore lost.

GUANO SERIES.

Guano increases the yield slightly, 2 cwt. giving an increase of 1·4 tons per acre; 4 cwt., of 3·7 tons; but when the 4 cwt. are given in two dressings of 2 cwt. each, the increase is slightly less, namely, 3·3 tons. From a monetary point of view, there is a loss in each case, the increased yield of cane not compensating for the cost of the guano.

TABLE I.

PLANT CANES.

MEANS OF 48 PLOTS FOR FIVE YEARS (1900-5).

No. of Experiment.	Tons of Cane per acre.	Difference on No Nitrogen.	Difference on No Manure.	Value of Increment.	Cost of Manure.	Loss on Manuring.	
				$ c.	$ c.	$ c.	s. d.
1	25·8	..	...	...	...	...	...
2	26·9	..	+1·1	2 86	...	...	...
3	26·8	...	+1·0	2 60	5 18	2 58	10 9
4	28·3	+1·5	+2·5	6 50	11 36	4 86	20 3
5	27·8	+1·0	+2·0	5 20	11 36	6 16	25 8
6	28·7	+1·9	+2·9	7 54	14 45	6 91	28 9
7	28·8	+2·0	+3·0	7 80	14 45	6 65	27 8
8	28·1	+1·3	+2·3	5 98	10 94	4 96	20 8
9	28·1	+1·3	+2·3	5 98	10 94	4 96	20 8
10	28·4	+1·6	+2·6	6 76	13 82	7 06	29 5
11	29·4	+2·6	+3·6	9 36	13 82	4 46	18 7
12	27·7	+0·9	+1·9	4 94	16 33	11 39	47 5
13	26·8	+0·0	+1·0	2 60	12 57	9 97	41 6
14	26·9	+0·1	+1·1	2 86	9 27	6 41	26 8
15	27·5	+0·7	+1·7	4 42	9 27	4 85	20 2
16	26·7	−0·1	+0·9	2 34	8 64	6 30	26 3
17	27·0	+0·2	+1·2	3 12	8 64	5 52	23 0
18	27·3	Difference on No Phosphate	+1·5	3 90	12 57	8 67	36 1
19	26·8	−0·5	+1·0	2 60	12 57	9 97	41 6
20	28·7	+1·4	+2·9	7 54	14 45	6 91	28 9
21	29·4	+2·1	+3·6	9 36	15 39	6 03	25 1
22	29·3	+2·0	+3·5	9 10	16 33	7 23	30 1
23	25·1	−2·2	−0·7	−1 82	1 88	3 70	15 5
24	29·1	+1·8	+3·3	8 58	15 29	6 71	27 11
25	29·1	+1·8	+3·3	8 58	16 65	8 07	33 7
26	27·3	Difference on No Potash.	+1·5	3 90	11 15	7 25	30 2
27	27·7	+0·4	+1·9	4 94	12 25	7 31	30 6
28	29·0	+1·7	+3·2	8 32	13 35	5 03	20 11
29	28·7	+1·4	+2·9	7 54	14 45	6 91	28 9
30	25·0	−2·3	−0·8	−2 08	3 30	5 38	22 5
31	26·4	...	+0·6	1 56	6 50	4 94	20 7
32	27·7	...	+1·9	4 94	13 00	8 06	33 7
33	27·4	...	+1·6	4 16	13 00	8 84	36 10

DIAGRAM 1. Corresponding with Table I.

Means of 48 plots for five years (1900-5).

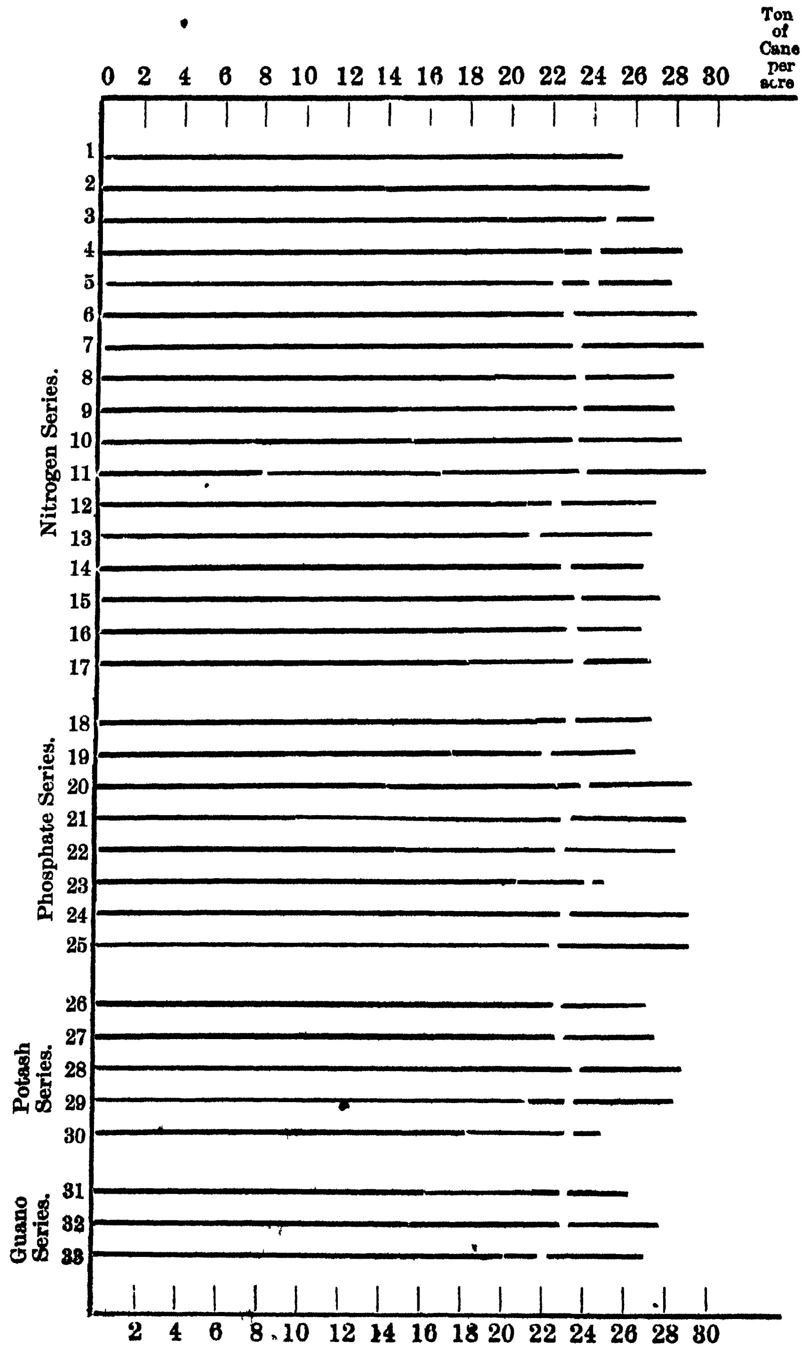


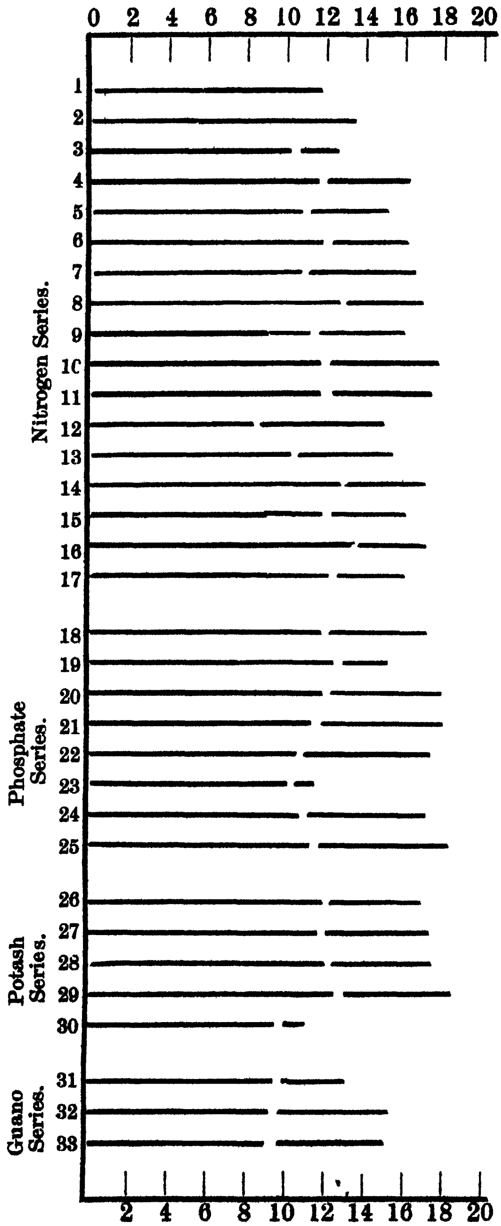
TABLE II.

RATOON CANES.

MEANS OF 30 PLOTS FOR FOUR YEARS (1901-5).

No. of Experiment.	Tons of Cane per acre.	Difference on No Nitrogen.	Difference on No Manure.	Value of increment.	Cost of manure.	Profit or Loss on manuring.	
				$ c.	$ c.	$ c.	s. d.
1	11·5	...	...	...	...	...	...
2	13·5	...	+2·0	5 20	...	...	...
3	12·9	...	+1·4	3 64	5 18	−1 54	− 6 5
4	16·6	+3·7	+5·1	13 26	11 36	+1 90	+ 7 11
5	15·3	+2·4	+3·8	9 88	11 36	−1 48	− 6 2
6	17·9	+5·0	+6·4	16 64	14 45	+2 19	+ 9 1
7	16·3	+3·4	+4·8	12 48	14 45	−1 97	− 8 2
8	17·0	+4·1	+5·5	14 30	10 94	+3 36	+14 0
9	16·1	+3·2	+4·6	11 96	10 94	+1 02	+ 4 3
10	18·0	+5·1	+6·5	16 90	13 82	+3 08	+12 10
11	17·2	+4·3	+5·7	14 82	13 82	+1 00	+ 4 2
12	15·0	+2·1	+3·5	9 10	16 33	−7 23	−30 1
13	15·1	+2·2	+3·6	9 36	12 57	−3 21	−13 4
14	17·1	+4·2	+5·6	14 66	9 27	+5 29	+22 0
15	16·1	+3·2	+4·6	11 96	9 27	+2 69	+11 2
16	17·4	+4·5	+5·9	15 34	8 64	+6 70	+27 11
17	16·1	+3·2	+4·6	11 96	8 64	+3 32	+13 10
18	17·3	Difference on No Phosphate.	+5·8	15 08	12 57	+2 51	+10 5
19	15·1	−2·2	+3·6	9 36	12 57	−3 21	−13 4
20	17·9	+0·6	+6·4	16 64	14 45	+2 19	+ 9 1
21	17·9	+0·6	+6·4	16 64	15 39	+1 25	+ 5 2
22	17·5	+0·2	+6·0	15 60	16 33	−0 73	− 3 0
23	11·5	−5·8	+0·0	0 00	1 88	−1 88	− 7 10
24	17·3	+0·0	+5·8	15 08	15 29	−0 21	− 0 10
25	18·4	+1·1	+6·9	17 94	16 65	+1 29	+ 5 4
26	17·0	Difference on No Potash.	+5·5	14 30	11 15	+3 15	+13 1
27	17·4	+0·4	+5·9	15 34	12 25	+3 09	+12 10
28	17·5	+0·5	+6·0	15 60	13 35	+2 25	+ 9 4
29	18·2	+1·2	+6·7	17 42	14 45	+2 97	+12 4
30	11·5	−5·5	+0·0	0 00	3 30	−3 30	−13 9
31	12·9	...	+1·4	3 64	6 50	−2 86	−11 11
32	15·2	...	+3·7	9 62	13 00	−3 38	−14 1
33	14·8	...	+3·3	8 58	13 00	−4 42	18 5

DIAGRAM II.—Corresponding with Table II
Means of 30 plots for four years (1901-5).



A REVIEW OF THE SUGAR INDUSTRY IN ANTIGUA AND ST. KITT'S-NEVIS DURING 1881-1905.

BY THE HON. FRANCIS WATTS, C.M.G., D.Sc., F.I.C., F.C.S.

The dependence of the presidencies of Antigua and St. Kitt's-Nevis upon the sugar industry makes it very desirable that the position of this industry should be critically examined with a view to ascertaining to what extent it is capable of supporting the presidencies, having regard both to the industrial and governmental aspects of the case. Such an examination may be more than usually useful at this juncture, seeing that the operation of the Brussels Convention has materially changed the condition of affairs in the world's sugar markets in a manner beneficial to the West Indies; seeing, also, that we are emerging from a period of disastrous speculations in sugar, which have masked the benefits of the Brussels Convention, and seeing that the presidencies under consideration have passed through a period of considerable depression.

In the first place, it must be recognized, that, until the present year, these two presidencies have been entirely dependent upon the sugar industry. During the last year cotton growing has made such progress as to have produced an appreciable effect in Nevis and Anguilla, and, to a certain extent, in St. Kitt's itself. Although cotton growing has made much progress in Antigua, it has not yet had any very marked effect on the trade of the island. Up to the present, therefore, the trade of these presidencies may be accurately measured by a consideration of the sugar industry.

In order to study the sugar industry, I have prepared, principally from the official records of the colony, a table showing the exports of sugar and molasses (and rum, in the case of St. Kitt's-Nevis) for the period 1881-1905, i.e., for twenty-five years, upon which land-tax is paid. For the better appreciation of the salient features of these statistics they have been put into diagrammatic form, and from them, I believe, many useful conclusions may be drawn.

In the diagrams the dotted lines indicate quantities (tons of sugar), and the solid lines values in pounds sterling. It is to be observed that the diagram is so constructed that when sugar sold for more than £10 per ton the solid line is above the dotted one; when sugar sold for less than £10 per ton the solid line falls below the dotted one; when the price of sugar was £10 per ton the two lines coincide. Sugar has been taken at the local value, i.e., at the price at which it has been sold, or has been assumed to be worth, on the spot.

It is observed that the values assumed for sugar have differed considerably between Antigua and St. Kitt's in the same season. It is not easy to account for this: it may be due

to the variation in the price of sugar during any particular season, whereby one island has sold its crop to greater advantage than another, while it may be, and probably is, due to different arbitrary values being adopted at the customs houses of the two presidencies. In this connexion it may be observed that there is usually a local market for sugar in Antigua.

Taking now the diagram relating to Antigua, and considering the points elucidated by the sugar curves, one is at once struck by the enormous decrease in the value of sugar exported, i.e., by the fall in the solid line. It is next seen that this fall is due principally to the decreased value of the ton of sugar during the period 1881-94. The value of sugar recorded fell below £10 per ton only in one year, 1887, while only twice in the subsequent period, 1895 to 1905, has it exceeded £10, i.e., in 1900 and in 1905.

During recent years there has been a falling off in the quantity of sugar produced, the curves of which will be discussed later. It is necessary, however, to point out at once, that this is not due to any diminution of effort to produce sugar, nor to any diminution of the area under cultivation in sugar-cane. A glance at the line showing the acreage of land upon which land-tax is paid,* as being under sugar-cane, will show that this line is practically horizontal. During 1896 and 1897 there was a slight increase, followed by a slight falling off. During the past few years the area under cane cultivation has been slightly greater, during the more prosperous period from 1886-1905. The effort to produce sugar has not been relaxed; indeed, as will be shown later, it has been increased.

The period from 1881 to 1894 may perhaps be taken as indicating the amount of sugar which Antigua can produce, from its present acreage, under average conditions: it includes some poor years and some good ones. The average annual production during this period was 13,113 tons, and its average value £163,700, or £12 9*s.* 8*d.* per ton. It has already been pointed out that during this period the price of sugar fell below £10 per ton only in one year.

From 1895 onwards matters have been less satisfactory, a succession of small crops and low prices having occasioned considerable hardships to all engaged in the industry. During the ten years from 1895 to 1904 the average annual production of sugar was 10,205 tons, its average value £83,370, or £8 3*s.* 4*d.* per ton.

The difference between the two periods is most striking. There is a falling off in the average output of sugar to the extent of 2,908 tons a year, but the falling off in value is much more striking and important. There is a diminution in value to the extent of £80,330 a year. In other words, the quantity of sugar produced annually during the ten-year period 1895 to 1904 has been, on the average, 77·8 per cent. of that produced annually during the period 1881-94, while the gross annual

* The area upon which land-tax is paid is greater than that from which the actual crop is reaped in each year, as land in preparation for planting in sugar-cane is included.

monetary value of the sugar of the latter period has only been 50·9 per cent. of that of the earlier period. Again, it must be urged that effort to produce sugar was not relaxed during the later period, but the effort only produced one-half of the monetary result that it did in the earlier period. It is impossible to over-estimate the seriousness of this to all concerned.

The fall in price is a circumstance over which the sugar producers of these islands have no control. Circumstances appear to point to a probable continuance of low prices, and it may be assumed that they will not depart greatly from the average of the period 1895-1904, namely, about £8 per ton. The diminution of production, however, demands inquiry.

The most striking feature in the whole diagram is the disastrous drop in 1895, a drop both in price and quantity; only one-half of the average crop being produced, while the value was only one-third of the average of the previous fourteen years. The falling off in quantity was due to the combined effects of drought and cane diseases, and it appeared as if the sugar industry were doomed to extinction. The following season was, however, a very favourable one, so far as weather was concerned, and the productions once more rose to the average of the period 1881-94. Cane diseases were prevalent, and, but for this circumstance, the crop would have been far above the average. It is reasonable to suppose that some 2,000 to 3,000 tons of sugar were lost this year from disease.

Cane diseases played an important part in reducing the crops during the period from 1894 to 1898. In 1894 many estates experienced difficulty in making sugar of good quality, the juice from the canes being weak and impure. It is now recognized that this was the first intimation of the existence of disease. Although some rotten canes were seen, the prevalent feeling was that the poor condition of affairs was due to drought, the rainfall of the two previous years (1892 and 1893) having been below the average.

In 1895 the condition of the cane fields was pitiable. Rotten canes were to be seen everywhere; in some cases the condition of affairs was so bad that scarcely any sugar at all could be made. From the fact that the previous growing season had again been a very dry one, the impression still lingered that drought was largely responsible for the disaster. This idea was, however, exploded the following year, for, although the growing season was a wet one, cane diseases were rampant, and the fields were filled with rotten canes.

In 1897 the crop was not very far below the average; cane diseases still existed to a certain extent, but were being rapidly diminished by the introduction of resistant varieties of sugar-cane. The crop of 1898 was another disastrously small one. This would appear to have been due very largely to the deficient and badly distributed rainfall during the growing season; for similar reasons the crops of 1898, 1900, and 1901 were very small. The two hurricanes which passed near to Antigua in 1899 were not without effect in reducing the crop of 1900.

In 1902, owing to better seasons, the crop nearly reached the average amount; unfortunately, the increased quantity was counterbalanced by the fact that the prices realized were the lowest on record.

The crops of 1903 and 1904 were below the average, while the crop of 1905 was disastrously short.

The variation of the crops during the period from 1898 to the present time is due almost entirely to deficient rainfall. Although in some years the total quantity falling may have been fairly large, the manner in which it fell was such as to lead to small crops: heavy rains alternated with disastrous periods of drought, or the rainfall was scanty during seasons when growth should have been taking place, but heavy at other times.

Referring to the reports on experiments with sugar-cane in the Leeward Islands, the following comments are to be fund:—

1900. 'Owing to the drought which prevailed during the early part of 1899, it was deemed undesirable to proceed with (certain) experiments.' (Report 1899-1900 p. 2.)

1901. 'The season was a poor one from an agricultural point of view, though better than the previous one: the rainfall was scanty.' (Report 1900-1, Part II., p. 1.)

1902. 'The present season up to March 1902 was an extremely favourable one for cane growing. Unfortunately, from April to July heavy rains fell making the reaping season one of unusual difficulty.' (Report 1901-2, Part I., p. 6.)

1903. 'The rainfall for this season was abnormal: April, May, and June in many places were unusually wet months: a dry period then followed, while in November extremely heavy rain fell, followed again by drought. In some places, owing to soil conditions, the unusual character of the rainfall produced disastrous results, so that the crop in those districts were far below the average. In other districts, particularly on the well-drained calcareous soils, this rainfall proved beneficial and large crops resulted.' (Report 1902-3, Part I., p. 7.)

1904. 'The rainfall was very variable. At most of the stations the weather was dry until August, after which some stations had good rains, but in some districts . . . . the drought continued until November. Speaking generally, the western districts had a fair rainfall following an early drought, while the eastern suffered more from drought up to the reaping season.' (Report 1903-4, Part I., p. 8.)

1905. 'The season . . . . has been a deplorably dry one, so far as Antigua is concerned, so dry that the sugar crop of the island was far below the average, only 7,800 tons, while some 14,000 or 16,000 should be expected.' (Report 1904-5, Part I., p. 9.)

From these reports it is abundantly clear that within recent years Antigua has experienced an unusual share of difficulties owing to unpropitious seasons. It is only reasonable to suppose and to hope that a series of more propitious seasons may again visit the island in the future as has happened in the past, and that the sugar crop may again reach, or exceed, the average of the period 1881-94, namely, over 13,000 tons a year.

Doubtless, during the recent period of intense depression, some deficiency may have arisen from a scarcity of money, whereby cultural operations have not been so well performed as planters could wish. It has already been pointed out that there has been no reduction in the acreage.

The stability given to the sugar industry by the abolition of bounties, by the operation of the Brussels Convention, has already led to a considerable amount of development in the sugar industry in Antigua in the past two years. The erection and successful operation of the central sugar factory at Gunthorpe's at a cost of £52,500; the conversion of Bendal's sugar factory into a small, but well-equipped modern factory at a cost of some £12,000, together with the extensive substitution of railway and tramway haulage for less perfect methods at both these factories, indicate a desire for progress such as has not been seen in the smaller islands for a generation or more, and is good evidence of a determination to do the best to make the industry successful.

Nor does the tendency towards progress end here. Two sets of steam-ploughing plant are expected to arrive in Antigua within the next few weeks, one being imported for working the lands associated with each of the above-mentioned factories. These, by deeper cultivation of the soil, are calculated to minimize the effects of drought. Concurrently with this, we may expect other improvements, all of which must have their effect on the production of sugar and the welfare of the island.

We are therefore justified, I think, in making some forecast of the future, and may reasonably hope to see the sugar crop in Antigua not only reaching to, but, by virtue of the improvements now introduced, exceeding, the crops of the period 1881-94; that is, exceeding, on the average, 13,000 tons. The price of sugar will doubtless be low, but at £8 per ton, at which price in an average year sugar can be produced at a small profit, this is worth £104,000, while there will probably be a steady increase in the amount of crystal (vacuum pan) sugar produced and a diminution of muscovado, thus increasing the value of the output. In addition to this, we may look forward to those developments which are sure to arise when the planting body is stimulated to a degree of activity exceeding anything which has existed in the past. Increased areas and improved methods of cultivation, improved varieties of canes, and various other improvements, such as may be anticipated from the intelligent working together of a well-equipped Department of Agriculture and active and alert planters cannot fail to result in beneficial changes.

It is clear that the sugar industry is to be improved by progress rather than by diminished expenditure and petty economies, though there is no margin for extravagant or unproductive expenditure. During the past ten years economy and reduction have been carried out almost drastically. The time now appears to have arrived for an effort at progress and increased expenditure in order to place the sugar industry on a sound footing, which could undoubtedly be reached, if it were not for the element of uncertainty introduced by unpropitious seasons. While, therefore, but a relatively small margin exists, the choice appears to lie between reduction and the ultimate extinction of the sugar industry on the one hand, and on the other, the development of the industry along sound lines of progress, leading, I believe, to its being placed upon a stable footing, thus providing a reasonably sure means of livelihood to those of all classes now engaged in it.

It would appear that in Antigua, at least, a decision has been cast in favour of the latter alternative, and the efforts of all engaged deserve the sympathetic support and mutual co-operation of the Government and of the proprietors of estates.

A similar review of the industry in St. Kitt's-Nevis is also interesting. In one respect there is a broad similarity between the conditions prevailing in the two presidencies: the earlier period, though containing many fluctuations, is relatively prosperous when compared with the later period, which is one of depression. Following the course of events, as shown on the diagram by the lines indicating the number of tons of sugar produced and their gross value, we see that, as in the case of Antigua, the period of great depression may be regarded as beginning in 1895, though in St. Kitt's this depression in 1895 is more marked in the monetary value than in the actual number of tons of sugar produced: evidences of falling off in quantity are seen in 1895, but the greatest period of depression is reached in 1900, when sugar touched both the lowest point in production and also the lowest point in gross value. It will be observed that this is five years later than the similar crisis in Antigua.

The fluctuations in the quantity of sugar produced in St. Kitt's-Nevis in the earlier period are greater than the fluctuations in Antigua during the same period.

The monetary depression during the critical period 1885 to 1887 appears to have been more keenly felt in Antigua than in St. Kitt's, for in Antigua the monetary curve is permanently depressed for all three years (1885-7) whereas in St. Kitt's the acute depression is only marked for one year—1886.

If we divide the period under review into two periods, the first consisting of the fourteen years 1881 to 1894, and the second of the ten years 1895 to 1904, as was done in the case of Antigua, we find that the general results present a striking similarity in the two presidencies.

From 1881 to 1894 the average production of sugar in St. Kitt's-Nevis was 16,078 tons, and the gross annual value was

£198,442, or £12 6s. 2d. per ton. During the period 1895 to 1904 the average annual production was 12,684 tons, having an annual value of £104,297, or £8 1s. 10d. per ton. The average amount of sugar produced during the later period is 80·1 per cent. of that of the earlier period; its value is only 52·5 per cent. It will be remembered that for Antigua the figures were 77·8 and 50·9, respectively. Both presidencies have therefore been compelled to carry on their sugar industry on about one-half of the monetary income to which they were previously accustomed—a fact which must be prominently kept in mind.

In St. Kitt's-Nevis this has led to the practising of great economy, and it seems doubtful if the reduction of expenditure in sugar production can be carried much further. The other alternative, the increase of production by the expenditure on improved methods, appears to offer the best solution of the problem. In this connexion one naturally thinks of the improvements and savings to be effected by the introduction of modern machinery installed in large factories. The results of the working of the pioneer factories in Antigua are being very closely watched, and, if these are as successful, as there is reason to anticipate they will be, doubtless there will soon be a movement in this direction in St. Kitt's.

In St. Kitt's-Nevis there is seen to be a falling off in the number of acres of land under cultivation in sugar-cane upon which land-tax has been paid. This chiefly took place between the years 1897 and 1898, when there was a reduction of 3,000 acres. The greater part of this reduction probably took place in Nevis, where, at the present moment, the sugar industry is carried on with much greater difficulty than in St. Kitt's, and where there is now a greater tendency to substitute cotton for sugar cultivation.

The fluctuations in the crop between 1881 and 1895 are to be accounted for chiefly by varying rainfall: 1882 was a dry year followed by a small crop in 1883; in 1884 and 1885 the rainfall was deficient, and a small crop resulted in 1886. Similarly, the small rainfall of 1889 and 1890 was followed by the small crop of 1891.

In the early nineties cane diseases were observed in St. Kitt's; at first the loss occasioned was not great, but the trouble increased until it culminated in the disaster of 1900. In this year some of the estates were in so bad a condition that ruin seemed imminent. From that time onward strenuous efforts were made to substitute new and resistant varieties with great success, so that, now, cane diseases cause little anxiety. The cane most largely introduced is the seedling B. 147; this has given excellent results and appears well suited to the conditions of St. Kitt's. Other varieties are being introduced with considerable success. The experiments with new varieties of canes, carried on by the Imperial Department of Agriculture, are here, as elsewhere, of the greatest importance to the sugar planters, who have, no doubt from painful experience, learned how dangerous it may be to trust too confidingly to a limited range of varieties of canes, and who,

perhaps, may now recognize the necessity for constant experiments in the production and propagation of new ones.

Owing to the fact that the cultivation of the cane is carried on more cheaply in St. Kitt's than in Antigua, due almost entirely to the difference in the character of the soil of the two islands—the soil of St. Kitt's being sandy and easily worked, while that of Antigua is, as a rule, heavy and more costly to handle—coupled with the fact that the rainfall in St. Kitt's is greater than the rainfall of Antigua, there has been less effort in St. Kitt's to introduce sugar-making machinery of a modern type. With the exception of one small factory, which has a vacuum pan but no triple effêt, the muscovado process is followed throughout. It would seem natural that at this juncture, the attention of the owners of sugar estates should be centred on the question of the advisability and possibility of introducing modern methods of sugar manufacture. Along this line appears to lie the course of development in the immediate future.

This brief review of the sugar industries of these two presidencies, extending over a period of twenty-five years, covers a period sufficiently long to enable us to ascertain fairly clearly the nature of the changes which have taken place and the difficulties which have had to be faced. The period is long enough to permit the fluctuations of short periods to be merged, and the 'crises' of abnormally bad years to be counterbalanced by good ones. We are thus left with the broad facts that, owing to adverse seasons and cane diseases, the production of sugar in the two presidencies has, during the past ten years, been reduced to about 79 per cent. of what it was during the previous fourteen years, while, worse still, the gross value of the sugar so produced has fallen to about 51 or 52 per cent. of what it was in the earlier period.

The fall in price of sugar has to be faced, and can be faced, by economies and improved methods, now that a measure of stability has been introduced by the operation of the Brussels Convention.

The fall in quantity of sugar produced is due to diseases and unpropitious seasons. Cane diseases appear now to be, to a very large extent, under control, thanks chiefly to the observations and work of various West Indian Experiment Stations. Unpropitious seasons may be expected to be subject to the law of averages; therefore, we reasonably hope that the future may be more propitious than the immediate past. In St. Kitt's-Nevis there is some falling off in acreage under sugar cultivation, the falling off being principally in Nevis. In Antigua there is no diminution of the cultivation, but rather a tendency to increase, coupled with very considerable progress in the matter of sugar manufacture, and improved methods of cultivation.

It augurs well for the stability of the sugar industry of these presidencies that it has been able to weather the steady depression of the past ten years, while our survey of the position gives good ground for hoping that the future will be brighter than the immediate past, so that, with careful handling

and judicious development, the sugar industry may be placed on as sure a basis as it has ever occupied.

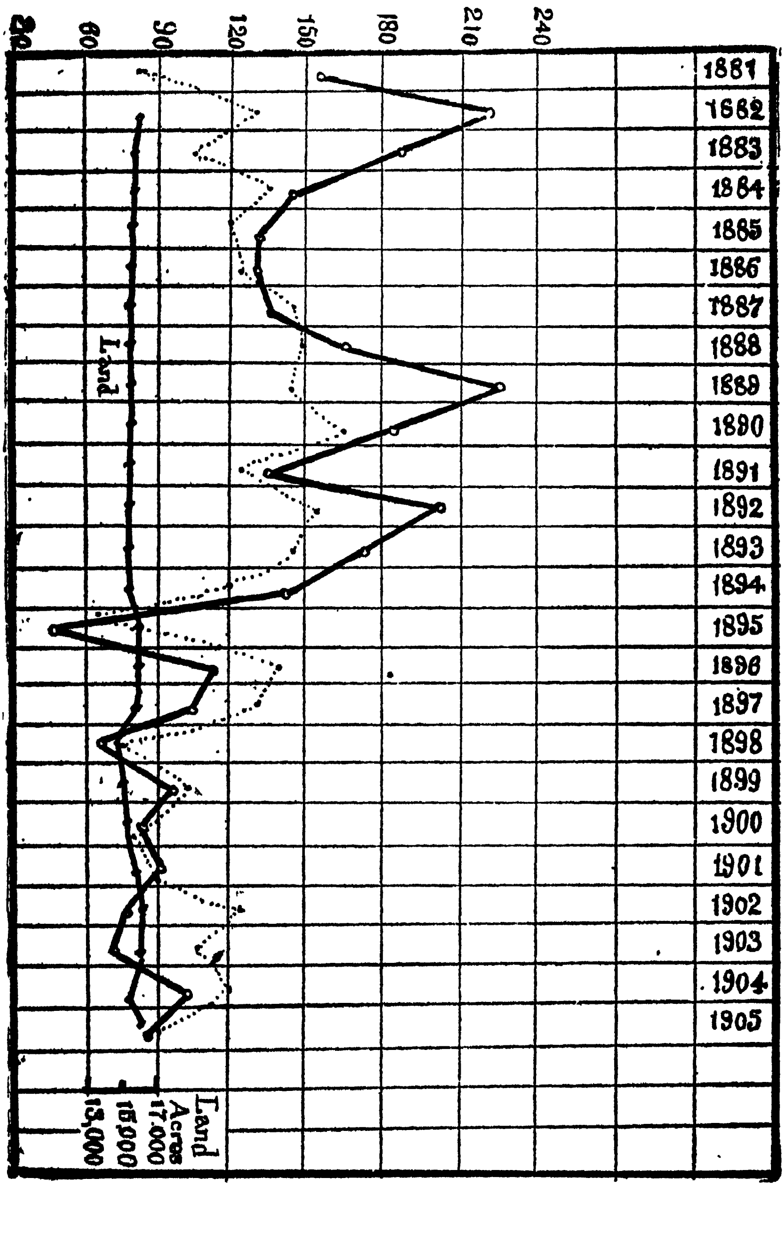
It is hoped that this brief review may prove useful alike to those responsible for the direction of affairs immediately connected with the sugar industry itself, and those responsible for the administration of affairs governmentally.

EXPORTS OF SUGAR AND MOLASSES FROM ANTIGUA, 1881-1905.

Year.	Tons of sugar.	Value of sugar.	Puncheons of molasses.	Value of molasses.	Acres of land in sugar-cane.	Value of 1 ton of sugar.
		£		£		£
1881	8,645	153,175	4,058	18,264		17·7
1882	12,769	218,297	8,369	41,845	(16,021)	17·1
1883	10,518	186,409	5,730	25,787	(15,918)	17·7
1884	13,721	145,601	7,083	21,249	(15,918)	10·6
1885	11,848	130,243	6,059	18,177	(15,291)	11·0
1886	12,271	129,347	7,301	21,904	(14,806)	10·5
1887	14,052	130,296	7,950	14,906	(14,806)	9·3
1888	14,925	160,881	8,551	28,503	(14,806)	10·8
1889	14,413	223,094	8,842	34,263	14,861	15·4
1890	16,120	180,701	7,585	28,723	14,860	11·2
1891	12,091	130,195	5,077	17,225	14,860	10·8
1892	15,302	199,893	10,372	35,005	14,860	13·1
1893	14,562	166,935	5,585	18,196	14,860	11·4
1894	12,342	136,794	6,676	20,030	14,860	11·1
1895	6,685	51,115	4,415	13,261	14,860	7·7
1896	13,714	111,155	6,648	7,479	15,611	8·1
1897	12,766	101,283	5,320	8,977	15,611	8·0
1898	6,968	63,246	2,438	4,764	14,286	9·1
1899	10,084	96,695	5,581	15,002	14,519	9·6
1900	7,662	80,372	4,648	17,626	14,519	10·5
1901	9,125	88,884	5,166	12,270	15,155	9·7
1902	12,611	74,727	8,248	8,420	15,130	5·9
1903	10,494	69,641	7,022	25,013	15,191	6·6
1904	11,940	96,585	5,249	10,595	14,759	8·1
1905	7,829	83,187	4,193	18,864	15,778	10·5

EXPORTS OF SUGAR FROM ANTIGUA, 1881-1905.

This scale indicates { values in thousands of pounds sterling— / quantities in hundreds of tons of sugar. .



EXPORTS OF SUGAR, MOLASSES, AND RUM FROM ST. KITT'S-NEVIS, 1881-1905.

Year.	Tons of sugar.	Value of sugar.	Puncheons of molasses.	Value of molasses.	Proof gallons of rum.	Value of rum.	Acres of land in sugar-cane.	Value of 1 ton of sugar.
		£		£		£		£
1881	12,316	208,165	4,821	22,725	48,345	4,395	..	16·9
1882	17,344	283,108	7,962	36,373	65,780	5,980	...	16·3
1883	13,868	207,093	5,520	27,600	41,580	3,780	...	14·9
1884	18,168	174,014	3,179	6,358	122,485	8,908	..	9·6
1885	15,150	161,590	3,787	10,414	168,905	11,515	...	10·7
1886	13,491	129,502	4,135	10,337	40,040	2,184	...	9·6
1887	19,313	189,578	6,537	15,265	86,130	4,698	...	9·7
1888	17,912	199,645	6,865	20,583	66,770	3,915	20,909	11·2
1889	17,466	268,976*	7,263	...	72,913	...	20,909	15·4*
1890	16,041	188,198	4,598	16,570	62,700	5,237	20,909	11·7
1891	12,014	148,835	3,685	14,742	110,851	7,759	20,909	12·4
1892	17,882	190,820	4,840	12,100	177,380	9,429	20,909	10·7
1893	17,056	239,601	4,576	13,848	121,490	6,351	20,909	14·0

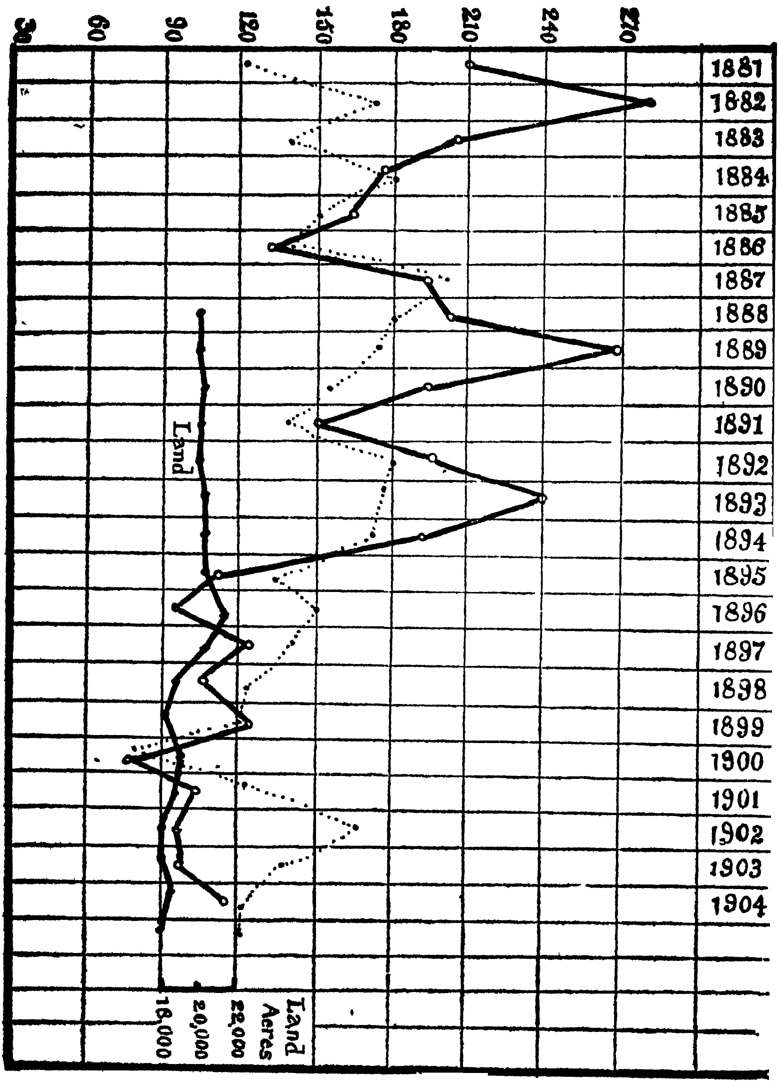
*Antigua value.

EXPORTS OF SUGAR, MOLASSES, AND RUM FROM ST. KITT'S-NEVIS, 1881-1905.—*Concluded.*

Year.	Tons of sugar.	Value of sugar.	Puncheons of molasses.	Value of molasses.	Proof gallons of rum.	Value of rum.	Acres of land in sugar-cane.	Value of 1 ton of sugar.
		£		£		£		£
1894	17,071	189,079	3,668	9,170	79,079	3,081	20,909	11·1
1895	13,149	111,954	4,030	10,075	86,450	3,859	20,909	8·5
1896	14,822	96,342	2,819	7,047	51,975	1,856	21,657	6·5
1897	14,450	122,834	2,261	3,768	70,686	2,528	21,657	8·5
1898	12,409	105,472	2,301	4,947	51,898	1,685	18,654	8·5
1899	12,011	126,096	2,638	7,617	42,042	2,275	18,090	10·3
1900	7,495	74,948	1,499	5,248	31,801	2,065	18,232	10·0
1901	12,146	103,239	1,940	3,637	59,426	2,581	18,456	8·5
1902	16,624	96,327	3,004	4,507	91,179	3,070	18,146	5·8
1903	13,511	95,153	2,695	8,085	30,515	1,129	17,791	7·0
1904	12,225	110,607	2,892	7,231	34,155	1,265	17,990	9·0
1905	12,042	...	2,859	...	39,798	...	17,791	...

EXPORTS OF SUGAR FROM ST. KITTS-NEVIS, 1881-1905.

This scale indicates { values in thousands of pounds sterling ——— ; quantities in hundreds of tons of sugar . . . .



THE FERMENTATION OF CANE JUICE.

BY THE HON. FRANCIS WATTS, C.M.G., D.Sc., F.I.C., F.C.S., AND

HAROLD A. TEMPANY, B.Sc., A.I.C.

When raw cane juice is allowed to stand for a few hours, under ordinary conditions obtaining in these islands, it undergoes a series of changes: the liquid becomes distinctly acid, assuming a yellow colour, and a dark scum rises to the surface; in common parlance the juice is said to sour. Upon longer standing alcoholic fermentation is observed and, finally, the juice becomes quite sour, forming the so-called cane vinegar.

The preliminary souring appears to be the point to which insufficient attention has been directed. What follows is an account of experiments intended to throw light on the changes which take place; much, however, remains for future work.

One would have expected that cane juice subjected to various degrees of fermentation would have constituted popular drinks under forms analogous to cider, wine, or 'pulque,' It is this souring which defeats this object.

The first step was to satisfy ourselves that, in addition to the preliminary souring, alcoholic fermentation took place. A sample of juice was therefore set aside; this soured in the usual manner, then a vigorous evolution of carbon dioxide took place, and a copious growth of an organism formed on the bottom of the flask. In fact, all the usual phenomena of alcoholic fermentation set in. Microscopic examination of the deposit showed that the greater part consisted of yeast, and inoculation of the growth into sterile sugar solution resulted in alcoholic fermentation taking place. Finally, the examination of the juice, after fermentation had proceeded for about nine days, showed the presence of 8·2 per cent. by volume of absolute alcohol. In another instance, after seven days, 8·6 per cent. by volume of absolute alcohol was found.

From this it appears that the original souring of the juice is merely a subsidiary phenomenon, and that alcoholic fermentation of the juice does take place on standing.

The question then arises: To what is this souring due? To investigate this point the following experiments were undertaken: About a litre of freshly extracted cane juice was placed in a flask of about 1,500 c.c. capacity and connected by means of a bulb-tube containing cotton wool, with a Kipps apparatus generating carbon dioxide. This was done in order to ascertain whether the oxidation necessary for the formation of acids takes place at the expense of the oxygen of the atmosphere, or if, in absence of air, the acidification proceeds in the same way as when air is allowed free access, then we must conclude that the oxidation necessary to the fermentation of acid takes place at the expense of some constituent of the juice itself.

The flask in which the experiment was conducted was provided with a side tube whereby samples of juice could be withdrawn from time to time for analysis.

Samples were withdrawn and analysed at regular intervals for a fortnight. Two similar series of experiments, A. and B., were performed, the results obtained being as follows:—

SERIES A.—IN ABSENCE OF AIR.

Date from commencement of Experiment.	Reducing Sugar as Invert Sugar or Glucose,* per 100 c. c.	Sucrose per 100 c. c.	Total Sugar per cent. as Sucrose and Glucose.	Acidity expressed as No. of c. c. $\frac{N}{5}$ Alkali, equivalent to 10 c. c. Juice.
1st. day ...	0·85	16·39	17·24	...
2nd. „ ..	0·99	14·90	15·89	3·15 c. c.
3rd. „ ...	0·94	14·22	15·16	4·20 „
5th. „ ...	9·54	3·41	12·95	7·10 „
6th. „ ...	10·61	0·04	10·65	8·60 „
7th. „ ...	8·54	0·00	8·54	9·10 „
8th. „ ...	4·04	0·00	4·04	9·90 „
9th. „ ...	2·56	0·00	2·56	10·20 „
10th. „ ...	1·66	0·00	1·66	10·15 „
12th. „ ...	0·45	0·00	0·45	10·00 „
13th. „ ..	...	...	...	10·15 „

* Hereafter referred to as Glucose.

SERIES B.—IN ABSENCE OF AIR.

Date from commencement of Experiment.	Reducing Sugar as Invert Sugar or Glucose, per 100 c. c.	Sucrose per 100 c. c.	Total Sugars as Sucrose and Glucose.	Acidity expressed as No. of c. c. $\frac{N}{5}$ Alkali, equivalent to 10 c. c. Juice.
1st. day ...	0·62	16·03	16·65	1·2 c. c.
2nd. „ ...	0·25	14·76	15·01	3·2 „
3rd. „ ..	0·48	13·60	14·08	4·9 „
4th. „ ...	1·09	11·93	13·02	6·2 „
5th. „ ...	5·15	..	..	8·3 „
7th. „ ...	8·33	0·00	8·33	9·2 „
8th. „ ...	5·22	0·00	5·22	...
10th. „ ...	0·98	0·00	0·98	11·8 „
17th. „ ...	...	...	...	11·8 „

In these experiments the reducing sugars were determined by titration against Fehling's solution, the sucrose by inversion and subsequent titration against Fehling, and the acidity by titration against $\frac{N}{5}$ caustic soda. In the first series of experiments no allowance was made for the acidity due to the solution of carbon dioxide in the liquid; in the second series, and in subsequent experiments, this source of error was eliminated by boiling the juice for a few minutes in a flask with an inverted condenser before titration, thus expelling any dissolved gas.

In this connexion it was found on the seventh day of the B. series of experiments that, before boiling, the juice showed an acidity equal to 10·1 c.c. of $\frac{N}{5}$ Alkali, and, after boiling, one equal to 9·2 c.c. of $\frac{N}{5}$ Alkali, so that in the later stage of the experiment the acidity due to dissolved carbon dioxide amounts, on 10 c. c. of juice, to somewhere about 1 c. c. $\frac{N}{5}$ Alkali.

In order to ascertain if the progress of the reaction was influenced materially by the presence or absence of air, a third series of experiments was undertaken in which air was not excluded from the interior of the flask, the neck of the flask containing the juice under experiment being merely loosely plugged with cotton wool. Samples were withdrawn and analysed just as in the previous experiments, and the following

results were obtained. Carbon dioxide was expelled before titrating for acidity:—

SERIES C.—IN PRESENCE OF AIR.

Date from commencement of Experiment.	Reducing Sugars as Invert Sugar or Glucose, per 100 c.c.	Sucrose per 100 c. c.	Total Sugars.	Acidity expressed as No. of c. c. $\frac{N}{5}$ Alkali, eqivalent to 10 c. c. Juice.
1st. day	0·15	17·42	17 57	1·4 c. c.
2nd. „	0·98	10·00	15·98	4·2 „
3rd. „	6 36	1·99	8 35	(5·0 „)
4th. „	4·12	1·63	5 75	7·2 „
7th. „	0·17		0·17	7·5 „

From these experiments two points are observed:—

(1) That the formation of acid is independent of the presence or absence of air.

(2) The disappearance of sugar, and presumably the formation of alcohol, proceeds much more rapidly when air is allowed free access to the juice, than when it is excluded. In this connexion it was observed that in the C. series the growth of yeast at the bottom of the juice and the evolution of gas were much more abundant in the early stages than in the A. and B. series. With this phenomenon, however, we are not at present concerned.

We will therefore return to the consideration of the formation of acid. Now, as the initial formation of acid is independent of the external presence or absence of air, the oxygen necessary for the oxidation of whatever constituent of the juice is converted into acid must be derived from one of the constituents of the juice itself. The points then to be settled are:—

(1) What constituent of the juice is oxidized to acid?

(2) What constituent of the juice supplies the oxygen necessary for the oxidation?

(3) What is the agency affecting the formation of acid?

With regard to the nature of the acid, the following experiment was performed in order to obtain some information on the subject: 100 c c. of a fermenting juice were taken, which at the time of experiment showed a total acidity of 10 c.c. of

juice, equivalent to 5·1 c.c. of $\frac{N}{5}$ Alkali. The juice was diluted with its own volume of water and distilled to dryness, the residue taken up with distilled water and distilled again, this process being repeated three times.

The whole of the distillate obtained was titrated against $\frac{N}{5}$ Alkali, and it was found that it was equal to 17·1 c.c. Thus we see that of the total acidity of 10 c.c. of juice equal to 5·1 c.c. $\frac{N}{5}$ Alkali, 1·71 c.c. is due to volatile acid (chiefly acetic), and the remaining 3·39 c.c. to non-volatile acid; that is, in about the proportion of two of non-volatile to one of volatile.

Now, as has been already stated, as soon as the juice sours, a black scum rises to the surface; it appeared probable that if, as seemed likely, the souring was due to the growth of an organism in the juice, this organism might be contained in the scum.

Microscopic examination of a small portion of this scum revealed the presence of a rod-like form of organism, 10-14 micro-millimetres in length and 1-2 micro-millimetres in thickness. To attempt to settle the various points at issue, the following experiment was performed: A sterile sugar solution was prepared containing 10 per cent. pure cane sugar, 1 per cent. pure invert sugar, and traces of phosphoric acid, potash, and nitrogen. The solution was first boiled and then sterilized intermittently, for several days, by heating to 100° C. in a steam bath. Into this sugar solution a small amount of freshly risen scum from a fermenting juice, was inoculated, and the preparation allowed to stand. At the end of twenty-four hours a felt-like growth was formed on the surface of the solution, and the liquid had developed a sour smell. Microscopic examination showed the growth to consist mainly of long, thread-like fibres of what appeared to be a mould form; at the end of forty-eight hours these seemed to have practically all broken down to rod-like forms similar to those already observed in the scum.*

After standing four days, the acidity of the solution was determined with the result that it was found that 10 c.c. of the solution gave an acidity of 10 c.c. $\frac{N}{5}$ Alkali.

These various observations serve to show: (1) That the acid is formed at the expense of the sugar and not of the non-sugar in the juice. (2) That the oxygen necessary for the oxidation of a portion of the sugar to acid is not derived from atmospheric oxygen, either in the air or dissolved in the juice. (3) That the actual process of formation of acid in the juice is due to the growth of an organism, originally present in the juice.

Further, it would appear that the only source which is

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* The slide forwarded by Dr. Watts contains an organism which probably belongs to the *Chlamydobacteriaceae* (of Migula). It may be a *Cladothrix* but Engler and Prantl make no mention of a *Cladothrix* being found in cane juice. [Ed. *W. I. B.*]

capable of supplying the oxygen, necessary for the oxidation to acid of a portion of the sugar, is the sugar itself.

Hence we should expect to find in fermented cane juice small amounts of some reduction product of sugar to account for the oxidation in question. In this connexion it may be noted that Marcano (*Comptes Rendus*, 108, 955) states that when cane juice ferments small quantities of mannite are always found to be present.

It was not found possible in these experiments to identify mannite, but it was noted that when fermented cane juice was evaporated down, traces were always found of some organic body crystallizing out in regular prismatic needles, and differing markedly in appearance from sugar, which, if Marcano's observation applies to juices in these islands, would appear to be mannite; a quantity of this substance sufficient to permit of any detailed observation was not obtained.

We have now arrived at a certain amount of insight into the primary process occurring when cane juice ferments; these primary fermentations are complete in a space of time varying from a week to ten days, during which time acids and alcohol are produced. If cane juice, in which the primary fermentations are complete, is allowed to stand in contact with air, secondary fermentation, of the normal acetic type, sets in, converting the previously formed alcohol into acetic acid. The acidity produced by this secondary fermentation is much greater than that produced in the primary souring; thus a sample of juice after standing about seven weeks gave an acidity of 10 c.c. = 33·6 c.c. $\frac{N}{5}$ Alkali, this same juice when the primary fermentation had ceased, had an acidity of 10 c.c. = 8·1· c.c. $\frac{N}{5}$ Alkali.

The setting in of this secondary fermentation is marked by the juice losing its yellow tint, and once more assuming a dark colour; the juice subsequently clarifies itself, depositing the suspended impurities as a sediment on the bottom of the containing vessel, leaving the juice as a deep-red, clear, strongly acid, supernatant liquid—the so-called cane vinegar.

During the course of these experiments, the following observations were made on the influence of the presence of small quantities of phenol on the fermenting power of cane juice:—

A litre of juice was taken and 20 c.c. of pure phenol were added to it. The juice was maintained in an atmosphere of carbon dioxide, as in the experiments already detailed, and samples were withdrawn from time to time and analysed. The results obtained were as follows:—

SERIES D.—WITH 2 PER CENT. OF PHENOL, IN ABSENCE OF AIR.

Date from commencement of Experiment.		Glucose per cent.	Sucrose per cent.	Total Sugars per cent.	Acidity expressed as No. of c.c. $\frac{N}{5}$ Alkali, equivalent to 10 c.c. of Juice
1st. day	...	0·85	16·39	17·24	...
2nd. "	..	0·94	16·01	16·95	1·0 c.c.
3rd. "	...	1·01	15·94	16·95	1·1 "
6th. "		1·05	15·63	16·68	1·8 "
8th. "	...	1·09	15·38	16·38	2·3 "
12th. "	...	1·51	14·65	16·16	2·9 "

A parallel experiment was prepared in which cane juice, to which 2 per cent. of phenol had been added, was allowed to undergo spontaneous fermentation in presence of air. Before fermentation the sample contained glucose, 0·15; sucrose, 17·42; total sugars, 16·92 per cent.; while the acidity of 10 c.c. was equal to 1·6 c.c. $\frac{N}{5}$ Alkali. After eight days the composition was glucose, 1·05; sucrose, 15·87; total sugars, 16·92 per cent., and the acidity of 10 c.c. was equal to 1·6 c.c. of $\frac{N}{5}$ Alkali. The acidity was unchanged.

The restraining influence of the presence of 2 per cent. of phenol on the fermentative power of the juice is very marked, showing clearly that the fermentative changes in the juice, resulting in profound modifications of the sugar content, are not due, as has been sometimes stated, to the action of enzymes normally present as direct constituents of cane juice, but rather to the presence of micro-organisms, which in their growth secrete the enzymes to which the various changes occurring are due; it is, however, well known that enzymes are present and are probably responsible for minor changes.

SUMMARY

Cane juice allowed to undergo fermentation spontaneously develops a considerable quantity of acids and alcohol. The acids are both volatile and non-volatile, the proportion being approximately two of non-volatile to one of volatile.

The production of acids appears to be due to a bacterial organism; the production of alcohol to a yeast.

The fermentation proceeds equally well in the absence of air as in its presence.

The acids are produced by the oxidation of cane sugar and the supply of oxygen is obtained from the reduction of a portion of the cane sugar, or of the glucose derived from it by inversion.

IMPROVEMENT OF SUGAR-CANE BY SELECTION AND HYBRIDIZATION.

BY F. A. STOCKDALE, B.A.,

Mycologist on the staff of the Imperial Department of Agriculture for the West Indies.

Probably no subject is of so much importance to planters of sugar-cane as that relating to the introduction and trial of new varieties. It would appear that the first announcement respecting the possibility of raising seedling canes in the West Indies was made at various times between 1859 and 1888*. A similar announcement was made in Java in 1887. Since 1888, their cultivation has been intelligently followed up and much improvement in the sugar-cane has resulted. Varieties have been raised which are capable of resisting, to a large extent, attacks of disease which destroyed the older forms, and this has led to a demand, still imperfectly satisfied, for the better kinds of canes. That climate and soil are the paramount influences exerted in the sugar-producing capacity of different varieties has clearly been shown by the difference in yields and other characteristics manifested by the same cane in different localities. The variety of soil and climatic conditions of the West Indies render it necessary to have many kinds of cane differing in their requirements, for it could not be expected to produce one single cane to suit all situations. Several experimental plots, in the different islands, were started to produce better canes, and the success of the results obtained must be very gratifying to those who have spent much time over these experiments, for the seedling canes produced in Barbados by Mr. Bovell and Professor Harrison, and by Mr. Jenman and Professor Harrison in British Guiana are now well known in most of the sugar-producing countries of the world. In striving to produce improved kinds of canes many features must be taken into account, amongst which the most important are: their germinative power, behaviour under excessive dryness or moisture, resistance to disease, ratooning power, milling qualities, fuel-producing property (depending on the percentage of fibre), quantity of juice and the productive yield of sugar. The last of these features is, no doubt, the one which claims the most notice, for maximum productiveness in most cases has not yet been reached and much is still to be gained in this direction.

The earlier method adopted for producing seedling canes was the careful selection of casually produced seedlings. A later step was the identity of seedlings from the seed-bearing parent. A further stage was raising seedlings from canes planted in alternate rows so that the pollen-bearing parent might be identified as well as the seed-bearing parent. Experiments in this direction have been carefully carried on at Java, Barbados, and British Guiana.

* Harrison: *Kew Bulletin*, 1888, p. 294.
Morris: *Journal Linnean Society*, XXVIII (1891), p. 197, plate 38.

The selection method practised in British Guiana was well described under separate heads by Professor J. B. Harrison at the last West Indian Agricultural Conference (see *West Indian Bulletin*, Vol. V., p. 337) as follows :—

'*first selection* of parent varieties for seed producers;

'*second selection* of the more vigorous of the seedlings obtained from them for field propagation;

'*third selection* of the varieties growing under field conditions by the cultural characteristics;

'*fourth selection* from these selected sorts by their analytical characters;

'*fifth selection*. The third and fourth methods are repeated with plants raised from tops of the varieties selected under the fourth selection, and this is done repeatedly during their cultivation from plants to second and third ratoons. As the method of cultivation in British Guiana renders it necessary for canes to have good ratooning powers to be of service as sugar producers, we lay more stress on the selection from ratoons than from plants;

'*sixth selection*. These varieties, which have been selected, are next grown on plots of about $\frac{1}{20}$ acre, side by side and under identical conditions of cultivation and manuring. On these their peculiarities are carefully watched, and out of batches of forty or so selected for this trial probably not more than a dozen will be retained in cultivation as third or fourth ratoons;

'*seventh selection*. During the course of the fifth and sixth selections, several of the varieties finally retained in cultivation will have been selected by planters by large-scale cultivation. These and a few others selected by ourselves are next examined by means of manurial experiments. Plots of about ½ acre are divided into smaller plots, and upon these the varieties are raised under varying systems of manuring. Some of the plots of every kind are manured with phosphates, and perhaps potash, others are not. Some of each are grown without any nitrogenous manures, others with increasing quantities of nitrogen. It has been found that the mean results of a kind under the varying kinds of manuring apparently offer the most reliable figures as to comparative value we can obtain on small-scale experiments.'

In Barbados, the selection of seedling canes, similar to that of British Guiana, has been practised for some years. Recently, however, an effort has been made to reduce the time in selecting seedlings by two years, by means of irrigation. The method adopted is as follows :—

After the canes are pricked out into pots and grown to about 1 foot in height, they are planted in the field during April and May of each year and irrigated. The following May, the canes are first of all selected for their field characters, and then crushed and tested for their saccharine content. The stools of those canes which are rich in sucrose and have given a heavy tonnage are taken up, divided in half, and replanted under

irrigation. The following December the canes from these stools are cut up and planted in the experiment plots to start their career in the successive stages of selection until the best of them—generally a very small percentage—attain the standard of being tested on acre plots.

At the Barbados and other experiment stations, the canes are grown under the ordinary conditions existing upon the estates where they are cultivated. The plots in which the seedlings are grown are arranged in duplicate. Each plot consists of 100 stools of canes arranged in four rows of twenty-five. For planting the next year, the canes from the outside rows are utilized; whereas the inner thirty stools are cut, weighed, and sampled. By recording the results from the inner rows only, the effects of one variety upon the growth of another and less vigorous variety are therefore eliminated. One hundred pounds of each sample are then crushed in the laboratory mill, the juice and megass weighed, and the juice analysed, from which data the results are calculated to the acre.

By means of this rigorous selection several good varieties have been raised, but a large percentage of the seedlings thus produced have proved to be worthless. The fixing of the good varieties is rendered easy, as plants raised from cuttings come true to the parent and do not necessitate, therefore, additional selection year after year. By this means thousands of seedlings have been raised every year, and after careful trial on experimental plots in different parts of the West Indies for several years in comparison with standard canes, the best are selected and recommended to planters for final trial under estate conditions. It therefore takes several years before a seedling cane has been sufficiently investigated to deserve recommendation to the planters, and then it must be left to the planter finally to select those which he thinks suitable for his cultivation, as a seedling may give very good results in one soil but prove an utter failure in another.

The difficulty, however, that had to be contended with by this method was that, although the seed-bearing parent was known and registered, the male parent was unknown, and therefore a vast majority of the seedlings were less valuable than the seed-bearing or female parent form originally selected. With a view to reducing this difficulty to a minimum, crossing has been resorted to, in the hope that some of the offspring will combine the good qualities of the two parents.

By this means, both parents are carefully selected, both have to be high in saccharine contents, and both have to possess good field characters. Hybrids generally possess a more vigorous growth, which provides suitable conditions to make it possible to obtain advantages resulting from the mingling of ancestral plasma-masses. Therefore, by hybridization, it is hoped to combine some of the desirable characters of both parents and therefore produce canes which can be highly recommended.

The first method by which hybridization was effected in the West Indies (and here it was that the first systematic

attempt was made to obtain hybrids of sugar-cane) is what might be called the natural method. Two good varieties known to arrow at the same time were planted in adjacent plots. Owing, however, to a large number of varieties being under cultivation, it was found almost impossible to ensure against the risk of pollen coming from an unknown source, and therefore this method had to be modified.*

The next method adopted was to plant varieties arrowing at the same time side by side in alternate rows, so as to present a chess-board pattern, and the cross-pollination left to chance. Some of the seedlings must have been produced from the parents by fertilization *inter se*, and a certain amount of uncertainty must exist as to the parentage of the resultant seedlings.

The Hon. Sir Daniel Morris, K.C.M.G., Imperial Commissioner of Agriculture for the West Indies, suggested another method for the hybridization of the sugar-cane, which is much more practical than those formerly used. Each arrow under experiment is bagged some time before it is ripe and when the pollen reaches maturity the contents of the bags of one variety are shaken (through temporary openings) into the bags of another which is to be the female parent. If precautions are taken to prevent the access of foreign pollen, this method is a good one and can easily be carried out.

A great advance, however, was made in the hybridization of the sugar-cane, when it was found that certain varieties do not produce fertile pollen, while their pistil is normal; whereas other canes produce a large amount of normal pollen. A great number of the better seedlings of Barbados were examined in the laboratory of the Imperial Department of Agriculture for the West Indies, and the investigations have enabled us to divide these seedlings into three classes: (1) in which the anthers show a large proportion of normal pollen; (2) in which the anthers show a very small proportion of normal pollen; (3) in which the anthers show a moderate proportion of normal pollen. † If, therefore, an arrow of a cane producing much normal pollen is bagged with an arrow which produces little fertile pollen, the risk of self-fertilization is reduced to a minimum, and if fertile seeds are produced by these canes, they will almost certainly be the result of hybridization.

The method now practised is a purely artificial cross-pollination, in which the flowers of one variety are emasculated, while still young, and then pollen is transferred from another variety by means of a camel's hair brush to those that have been emasculated. This experiment was successfully carried out by Mr. Lewton-Brain (now Assistant Director of Vegetable Pathology, Hawaiian Sugar Planters' Association) in November

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* d'Albuquerque: 'Notes on Artificial cross-fertilization of Sugar-cane.' *West Indian Bulletin*, Vol. I, pp. 182-4.

Kobus: *Revue des Cultures Coloniales*, T. VIII, 1901.

† Lewton-Brain: 'Hybridization of the Sugar-cane.' *West Indian Bulletin*, Vol. IV, pp. 63-73.

1904, when he was Mycologist on the staff of the Imperial Department of Agriculture for the West Indies. He worked with some of the best of the Barbados varieties and obtained five seedlings, which proved that the raising of hybrid sugar-canes by artificial cross-fertilization is practicable. These are the first seedlings raised in the West Indies whose parentage is a matter of certainty. They are being carefully propagated, and instructive results are expected to follow. The method adopted by Mr. Lewton-Brain is described by him in the *West Indian Bulletin* (Vol. V., pp. 362-3) as follows:—

'A strong, movable platform was constructed, 8 feet high, the top being 6 feet by 4 feet. On this, there were boxes of different sizes, which served as tables and stools of varying height. The stamens were removed under the dissecting microscope, and the chief difficulty was found to be that of keeping the spikelets steady under the lens while the work was going on.

'Arrows which were just beginning to emerge from the upper leaf-sheath were always selected. The cane was bent over carefully to the table, and tied firmly to neighbouring canes and to the platform. The lower part of the arrow was placed in a clamp, the foot of which was then screwed into the top of the platform. All this had, of course, to be done with the greatest care, so that no undue strain was put upon any part of the cane.

'The table and dissecting microscope were then shifted into as convenient a position as possible, and the stamens were removed from about a dozen to twenty spikelets, preferably on several branches of the arrow. This operation proved to be one of some difficulty and delicacy under field conditions; frequently the stigmatic plumes were removed or injured before the third stamen could be got out. It was found necessary to work with one's back to the sun to avoid the glitter from the glumes and hairs.

'The remaining spikelets on the arrow, including, of course, all those that had emerged into the air before the operation, were then removed.

'Meanwhile a strong pole, 16 feet high from the ground, had been fixed near the base of the cane. To this, near the top, was fixed a wire cage, sufficiently large to include easily the whole arrow; the cage was made in two halves which were left sufficiently apart to admit the arrow. The cane was now gently and gradually released and the arrow brought into the cage: this was then closed and covered with fine, strong muslin. The whole was sewn up carefully, and the cane and arrow tied up to the pole; in some cases, too great a strain was put upon the upper part of the cane in the tying, and the arrow dried up. A few days later, when the stigmatic plumes were seen to be turning red and opening out, pollination was performed, and the muslin again sewed up.

'The whole process is tedious and one that requires great care and delicacy at every point. Under the conditions, this is

not always easy. Even then, a sudden gust of wind or a sudden shower of rain may spoil a morning's work.'

In view of the success of this work, is was decided this year (1905) to commence systematic attempts to raise new hybrids. Owing to fluctuating variations in some of the new seedlings, only those which had stood the stringent tests on a large scale for a considerable time, were used in the experiments. Of these, B. 147 and B. 208 were considered the best, and over 400 spikelets of these two varieties were emasculated and pollinated. The method adopted was practically similar to that described above, there being a few slight practical deviations. The staging was made 1 foot higher so that the cane under experiment did not have to be bent so much from the upright position. The arrow which was to become the seed parent was carefully selected on a cane free from disease, bagged before it began to emerge from the leaf-sheath, and allowed to remain until a length of at least 6 inches presented itself in the air and to the rays of the sun. It was found that very young spikelets were affected seriously by the sun after they had been operated upon, but that, if they remained exposed until the glumes were beginning to turn slightly red, they stood the severe handling much better. Careful microscopic examination of the flowers at this stage revealed very little mature pollen in the anthers and the stigmata were not in a receptive condition, being still in the white, immature state. There could, therefore, be no danger of self-fertilization. It was also found that if the spikelets happened to present a lateral view, the glumes could easily be separated, and the anthers removed without rupture. The numerous spikelets are generally arranged in pairs, one being sessile and the other stalked. The sessile spikelets are much larger than those on the stalks, but the slightest touch removed them from the spike, so that most of the work had to be performed on the stalked spikelets.

Three sound canes were chosen from the varieties to be used, and at least a dozen spikelets in each arrow were operated upon. Two or three spikelets were left on each spike in order to distribute those emasculated throughout the arrow. The emasculated arrow was then tied securely to the pole and brought into the cage covered with strong muslin. The pollen-bearing arrow was then cut off and a portion of it tied with the cut end in a bottle containing water to the pole, which was erected to support the cane. By this means, it is possible to keep the pollen-producing arrow alive for from two to five days and therefore produce a constant relay of fertile pollen for pollination. When the stigmata appeared, each of the spikelets emasculated was pollinated twice by means of a camel's hair brush, a separate brush being used for each variety.

Crossing was performed in two directions, the pollen parent in one cross being used as the seed parent in the other cross; in other words, one variety was utilized as the female parent in one cross and as the male parent in the other. Over 600 spikelets have been emasculated and artificially pollinated this year, and it is hoped that the results

obtained may be such as will before long be appreciated by sugar planters. A concise account is being kept of the crosses performed, and next year it is hoped that a series of investigations with the cytology of the sugar-cane will be carried on, with a view of obtaining, if possible, the right age for pollination.

Experiments have also been carried on by Professor J. P. d'Albuquerque and Mr. J. R. Bovell in Barbados, Professor J. B. Harrison in Demerara, and Dr. Francis Watts in Antigua, with the object of ascertaining if a higher saccharine content of a certain variety can be induced by repeatedly selecting plants from the richest plants of that variety. This is usually referred to as chemical selection. The results so far obtained appear to be conflicting, but it seems that a greater yield of sugar will only be induced by careful crossing of the better varieties.

It is now certain that a class of canes has been raised in the West Indies that possess not only a greater sugar-producing quality than the older varieties, but also possess, to a large extent, those qualities which enable them to resist disease, so that the planters are now able to override the obstacles which occurred in the cultivation of the older varieties.

The first object for which seedling canes have been raised has, to a large extent, been accomplished, for these new varieties have now been tested in different localities for a sufficient period of time to demonstrate their disease-resisting qualities; and therefore we now have to turn to the other qualities which go to form our ideal. In the selection of varieties for crossing, the sugar-producing capacity is all-important, but considerable notice should be taken of the field characters, especially when it is generally known that planters have a great objection to many canes, because they do not present a pleasing aspect when in growth.

The introduction of these new seedlings in the West Indies has been fully appreciated not only here, but also in other parts of the world, for Barbados and Demerara seedlings have shown that they are superior in many respects to the home canes in such sugar-producing countries as Louisiana, Queensland, Hawaii, and Cuba.

The Bourbon cane was formerly the standard cane in the West Indies, but the results of experiments with seedling canes on a large scale 'indicate an increased yield per acre of from 12 to 20 per cent. over that of the Bourbon.' The seedlings that are best known in most parts of the world are D. 109, D. 74, D. 95, B. 147, and B. 208.

The last two mentioned have successfully stood the test for many years on an estate scale all over the West Indies and present many characteristics which make them worthy of special mention. This year the crossing of these two varieties has been performed, and it is hoped that not only will a good variety result, but that data will be obtained which may prove useful in helping to trace the dominant and recessive

characteristics of each variety, when these crosses are allowed to fertilize themselves.

Several arrows of the better of our varieties are being bagged separately so that they may fertilize themselves, and therefore the resultant seedlings will give some clue to the more prominent characters of these varieties, and will be of assistance in the further crosses that will be made.

The planters in the West Indies freely express their appreciation of the advantages that they have derived from the introduction of these selected varieties and feel that they are now in the possession of a powerful defence against many forms of cane disease.

In Demerara, up to the beginning of 1905, nearly one-third of a million of seedling canes had been raised by the selection method, and 26,000 of these had been selected for field experiments. A few hundred have been selected from these for continued experiments, and practically every estate in the colony has its experimental plot. It need only be stated that at least 12,000 acres are being cultivated in new seedling varieties, to show that planters fully appreciate what has been done for them in the matter of new varieties of canes.

In Jamaica a large number of seedlings have been successfully raised and several others have been introduced. B. 208 is extensively cultivated on an estate scale, and it is now evident that the splendid qualities of this cane are the outstanding features of the trial plots there, for it has given nearly double the quantity of canes per acre produced by the older kinds.

In Barbados during the last five years over 20,000 varieties of seedling canes have been raised and planted out, but less than 1 per cent. of these have stood the stringent tests of field and chemical selection applied to them. Seedling canes were brought into early prominence here owing to the failure of the Bourbon cane through attacks of fungoid disease, and they have shown that they are capable of considerable resistance to attacks of disease and at the same time give a larger yield of sugar per acre. Many of these seedlings have been distributed to other West India Islands.

The Hon. Dr. Francis Watts in Antigua states that 'by means of the introduction of new varieties of canes the planter has now an opportunity of selecting his canes for particular soils and situations. In this way, he may not necessarily select that cane which has done best, on the average of the whole of the experiments, but his own observations may have led him to see that some particular cane will prove suitable for some special condition, and he selects suitable canes accordingly.'

The Imperial Department of Agriculture for the West Indies has been the means of raising several thousand seedlings every year, and it is hoped that the seedlings obtained by hybridization will lead to varieties of sugar-cane, the pedigrees of which will be known, which will prove of commercial importance to producers of sugar.

It is fully realized that it is necessary to improve the crops by breeding continually for greater vigour and hardiness, and that definite qualities can be induced and intensified so long as systematic attention is directed solely toward this aim.

Over 20,000 plants (tops and portions of stems of seedling sugar-canes) are annually exported from Barbados to other West India Islands, in all of which the area under seedling canes is gradually extending and it is hoped that a general improvement of the sugar industry will result from a continuation of the conjoined efforts of the experimentalists and members of the planting community.

ERRATUM IN THE PRESENT VOLUME.

Page 146, line 14 from bottom, *for* 'better with shade than without' *read* 'better without shade than with.'

Imperial Department of Agriculture

FOR THE WEST INDIES.

HEAD OFFICE—BARBADOS.

Imperial Commissioner of Agriculture for the West Indies	The Hon. SIR DANIEL MORRIS, K.C.M.G., D.Sc., D.C.L., M.A., F.L.S., F.R.H.S., C.M.Z.S.
Scientific Assistant	W. R BUTTENSHAW, M.A., B.Sc.
Entomologist	HENRY A. BALLOU, B.Sc.
Mycologist and Agricultural Lecturer	F. A. STOCKDALE, B.A.
Travelling Inspector in connexion with Cotton Investigations	THOMAS THORNTON, A.R.C.S.
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Assistant Clerk	MURRELL B. CONNELL.
Junior Clerk	LIONEL B. MASON.
Typist	BEATRICE ROBINSON.
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Messenger	W. H. BOURNE.

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Professor J. B. HARRISON, C.M.G., M.A., F.I.C., F.G.S.

Professor J. P. D'ALBUQUERQUE, M.A., F.I.C., F.C.S.

Government Analytical and Agricultural Chemist and Superintendent of Agriculture for the Leeward Islands,

The Hon. FRANCIS WATTS, C.M.G., D.Sc., F.I.C., F.C.S.

List of Staffs of Colonial Establishments.

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Clerical Assistant... ...	C. E. STOUTE.

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Chemist-in-charge ...	Professor J. P. D'ALBUQUERQUE, M.A., F.I.C., F.C.S.
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Laboratory Assistant ...	D. E. SEALE.
Pupil Assistant	S. D. BASCOM.
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Assistant do. ...	C. T. MURPHY.
Junior Assistant	J. O. MALONEY.

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TOBAGO.

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Curator	HENRY MILLEN.
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Foreman	J. BLACKMAN.

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ST. KITT'S-NEVIS.

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Assistant Supt. of Hope Gardens	N. A. RUDOLF.
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Clerk at Head Office	F. N. ISAACS.
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List of Staffs of Colonial Establishments.—(*Concluded.*)

JAMAICA.—(*Concluded.*)

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Assistant Chemist	E. J. WORTLEY.
Second Assistant	G. D. GOODE.

Sugar Experiment Station:

Chemist-in-Charge	H. H. COUSINS, M.A., F.C.S.
Fermentation Chemist ...	CHARLES ALLAN, B.Sc.
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Head Gardener	JOHN F. WABY, F.L.S.
Assistant Gardener	F. W. B. CARTER.
Clerical Assistant	E. S. CHRISTIANI.
Keeper (Berbice)	J. NARDAMOONIE.

Agricultural Experiments and Education.

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Science Master (Queen's College)	E. W. F. ENGLISH, B.A.
Normal and Agricultural Master	E. G. CHAMBERLAINE.

TRINIDAD.

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Clerk	H. C. MASSY.
Overseer (St. Clair)	A. COLLENS.
Herbarium Assistant	PAULINE MCLEAN.
Agricultural Instructors ...	WILLIAM LESLIE. H. A. NURSE.
Manager (River Estate) ...	J. C. AUGUSTUS.

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